CHAPTER V.—IRON VESSELS.

Not more than eighty years have elapsed since iron was first employed in place of wood in the frames and outer planking of vessels. There are some men still living in England who remember the very first boat of this material, which was a little canal-boat with a wooden frame and bottom and sides of boiler iron. The lightness and buoyancy of the hull were the points that attracted attention at the time and led to the construction of other boats of the same class. It was at first supposed that iron hulls, on account of their light draught, would be best adapted for canals and rivers, and all the first vessels were intended for use on one or the other of those two classes of water routes. The first steamboat, a small affair, was manufactured at Horsley in 1821, put together in London, and then sent to France. A boat for the river Seine was shortly afterward exported in pieces from England and put together at Charenton, and in the course of the ten years following 1821 quite a number of small river steamboats were built for companies in England and on the Continent. There then followed a few packets for use on the coast. Finally, in 1838, sailing vessels of from 200 to 300 tons register were built at Liverpool and elsewhere for voyages to foreign lands. After 1840 the building of iron vessels for all trades became a permanent and prosperous industry. What tended to bring them into favor first was their lighter weight and longer life; a decisive victory was won for them when, in 1840, it was finally determined that for all large tonnage it was cheaper to build of iron than of wood. Timber had grown scarce and dear in England; on the other hand, iron and coal were cheap. As soon as builders had acquired sufficient confidence to make iron vessels a specialty it was found that they could build at a considerable saving on the first cost of a wooden ship, as when they learned to distribute materials properly they decreased the weight of the iron ships, built them at a lower cost, and saved from $10 to $20 per ton on the cost of a wooden vessel. This was an important point, and the result was seen in the rapid development of the industry in localities favorably situated with respect to the iron and coal mines. After 1840 a great deal of capital was invested in iron tonnage in England, and the production of wooden tonnage steadily declined year by year until, in 1882, it has virtually come to an end.

In America timber has always been cheap and abundant. The wooden ship has always been the cheap ship, and it remains so to-day. A strong motive for the production of iron tonnage never came to our people until after they had been for some time employing long and large steam vessels in the deep-sea trades. It is true that several small revenue-cutters, tugs, and steamboats had been built of iron in this country prior to 1840, and the subject of iron hulls for large-class tonnage had received a great deal of attention in the principal commercial cities. The superior buoyancy and durability of iron hulls were recognized, but their cost was a serious disadvantage; and Americans saw no reason for abandoning oak and pine for iron until experience had taught them that for large steamers strength and rigidity of structure were considerations of far greater importance than first cost. They then took up the question of the new material seriously, and the result was that after 1850 there began a movement which has finally led to the almost entire disappearance of wooden hulls in American steamers in the deep-sea trades and the universal adoption of iron hulls. For sailing vessels oak and pine retained their popularity; and although it is nearly 60 years since the first iron vessel was launched in America, not more than a dozen sailing vessels and half that number of barges are known to have been built in this country of any material except timber. The iron ship lasts longer; but the wooden ship is far cheaper, is practically as good a carrier, and, all things considered, is about as profitable. There is not much inducement for making sailing tonnage of iron, and there apparently will not be until the first cost of the two is more nearly equal than it is now. On the other hand, at least 590 iron steamers in all have been constructed, and the production has now reached a total of from 20 to 40 a year, and is steadily growing.

There is no record of the building of an iron vessel in the United States until 1825, when the little light-draught steamboat Codorus was launched in Pennsylvania for service on the Susquehanna river. This was four years only after the advent of the first iron steamboat in England. The Codorus may possibly have been one of several which were exported from England in pieces to America and put together here during that early period, but on that point nothing can be definitely stated. The boat was employed on the Susquehanna for a while, and was then sent south for river service there. In 1835 there were five iron steamers already on the Savannah river which appear to have been built in the north. New York was foremost in the matter of iron steamboat building in that early time. In 1836 a steam vessel of 600 tons was launched, originally with a view to trading to Europe. She was put into the mail service to New Orleans first, however, but subsequently abandoned the transatlantic branch of her career. In 1838 a pioneer iron steamboat was built in the West at Pittsburgh. There was next, in 1841, a revenue-cutter built at Boston. As early as 1842 Philadelphia had produced a line of small iron steamboats to trade to Hartford, Connecticut. That year was, relatively, a favorable one for the rise of an iron ship-building industry in the United States, for iron had just touched the lowest prices ever known on this side of the Atlantic. Pig metal had been as high as $55 per gross ton after the war of 1812, and again as high as $52 50 just before the panic of 1837, while the average price had been $35, and it had never fallen as low as $27 50 until 1842. Anthracite iron went as low as $25 per gross ton in that year, and in 1844 it dropped to $24. Nothing like it had been known. The drop had a favorable effect on iron-vessel building, but only for a short time, because railroad building caused a rise in value of $8 per ton within a very few years. While iron ranged low a number of boats, all of moderate size, were built in New York and Philadelphia, and a now famous yard was started at Wilmington, Delaware; the most work appears to have been done in New York, the industry being fostered in that city by the great marine-engine shops, four iron revenue-cutters being built there in 1843, and a number of small merchant steamers about the same time. Then came the rise in iron. In 1850 iron had dropped again, pig metal going to $20 per ton, and a new yard was started in Boston. At New York there was some production, but again iron rose in value; and in 1854 prices had gone to $38 per ton, almost double what they were four years before. Few vessels were built, therefore, and these chiefly on foreign account, until 1858, when the general dullness in trade had brought the price of pig metal down again to $21 50. There was then every prospect of a prosperous growth in the industry. Materials and labor were both low, as they generally are at the same time in iron-ship building, for the raw materials of this industry are in reality the highly finished products of skilled labor, and the cost of materials is directly dependent upon the current rates of wages. American builders were learning to handle iron, and their workmen were becoming trained in the routine of the ship-yard. In addition to these things was the fact that the superiority of American iron had been discovered; an important matter, because it enabled American builders to construct hulls as light and strong as any in the world with a smaller quantity of material than would be put into similar vessels in England.

After the war of 1861 had broken out the value of every form of cast and rolled iron sprang up in a remarkable manner. In 1864 pig metal had touched $73 50 per ton, the highest figure in the history of the United States, and the average of that extraordinary year was $59 25, something entirely unprecedented. Wages also rose to the highest point perhaps ever known, for the army drew off an immense number of workmen. Other circumstances remaining as they were before the war, these events would have closed the gates of every iron-ship yard in America; but the period was exceptional, and those four years were, in fact, years of intense activity in all the yards. It was necessary to construct a large number of iron-clad war vessels immediately, and in the emergency the reliance of the government was almost wholly upon private ship-yards. Foreseeing that this would be the case, the proprietors in Boston, New York, Philadelphia, and Wilmington fitted up their yards in anticipation, putting in expensive machinery for the bending of iron frames and plates, the punching of rivet holes, and the forging and handling of iron bars and shafts. The contracts which they afterward received enabled them to go on and improve their plant, and several firms invested from $250,000 to $1,000,000 each in shops and machinery of the most massive description. The liberal expenditures for armored vessels during the war gave the iron-ship building interest the most powerful impetus it has ever received. The government was compelled from necessity to do that which had been done in England in times of peace from public policy, and was obliged to supply private ship-yards with so large a volume of business that they were thereby placed upon a solid basis of large capital and improved plant. This result has since proved of immense value to that part of the commercial community which is compelled to own and employ steam vessels in deep-sea trade, and has firmly established the art in the United States, improved the quality, and decreased the cost of American iron-built ships. The yards were dull immediately after the war, that is to say, from 1864 to 1870, because the government orders ceased, and there was an era of high prices, during which iron and labor were costly; but after 1870 iron went down rapidly, reaching $16 50 per ton in 1878, the lowest point in American history, and the price has ever since remained at a moderate figure. Steamer building became active in 1870 for the coasting trade, for companies in South America, and to a limited extent for our own foreign trade, and it has ever since gone on steadily and profitably. New yards were opened after 1870 on the coast, on the northern lakes, and on the western rivers.

No official separate record was kept of the iron-ship building of the United States until about 1868. In order to show the full extent of what has been done an attempt has been made to prepare a table of the production for this report; (*a*) but the only statement that can be made is one prepared by the Register of the Treasury, which, however, does not include about 100 vessels built on foreign orders and a number of coast survey, revenue marine, and other government vessels. It is as follows:

Year.	No.	Tonnage.	Year.	No.	Tonnage.
1868	....	2,801	1875	20	21,632
1869	....	4,584	1876	25	21,346
1870	....	8,281	1877	7	5,927
1871	....	15,479	1878	32	26,960
1872	20	12,766	1879	24	22,008
1873	26	26,548	1880	31	25,582
1874	28	33,097	1881	42	28,536

a Data have been gathered showing that almost exactly 600 iron vessels (not including war ships) have been constructed in the United States down to the year 1883; but the years when the ships were built and their register tonnage cannot be accurately tabulated without first incurring an amount of labor entirely out of proportion to the value of the figures when obtained.

Iron ships are constructed on the same general principle as wooden ones. They have a strong backbone or keelson of vertical iron plates, and at right angles thereto ribs or frames, running from the keelson to the gunwale of the vessel and giving to the hull its shape. The frames are strengthened across the floor of the vessel by having riveted to them vertical floor-plates extending from bilge to bilge. There is no ceiling in an iron ship other than a light plank flooring in the bottom of the hold and narrow strips or battens up the sides to keep the cargo from the iron work; but the lack of a heavy ceiling, such as is put into a wooden ship, is made up by greater thickness of outside plating. The outside of the frames is covered with strong iron plates, 6 to 8 frame spaces long and about 2 wide; the edges of each strake lap, and are fastened by a double row of rivets; the butts of the plates are fastened to each other by a strap inside, riveted to each plate by a triple row of rivets. The laps and butts are tightly sealed and made water-tight with hammer and chisel, and the plating makes a perfectly rigid outside shell, which gives the principal strength to the ship. The decks are supported by beams of iron, put in the same as the beams of a wooden ship and kneed to the sides of the vessel with iron knees, which, in this case, however, are part and parcel of the beams themselves. In its whole design the iron ship follows closely the structure of its wooden prototype, the only variations in construction being those which spring from assembling bars and plates in the one case and beams and planks in the other to produce a finished vessel. It is a much simpler process to build an iron ship than it is to build a wooden one. For instance, a frame, while composed of two angle-irons riveted back to back, extends in one length from the keel to the plank-sheer, whereas in the wooden hull the frame is made up of a large number of short pieces, which must be arranged with much care and ingenuity and be properly fastened together before the frame can fulfill the object of its existence. The plating of an iron vessel is also a simpler and easier affair than the planking of a wooden hull. The same simplicity prevails throughout the whole structure. It is only required that the work of the ship shall be done accurately. If frames are a little out of the true curvature they cannot be dubbed off with an adze after they are in position; they must be bent to exactly the right curvature in the first place. A bad seam cannot be closed with oakum, nor will iron, like wood, swell in water and close up the seams. In the iron ship all the parts must be made of the true shape before they are fitted into the vessel, and must match each other exactly, perfect accuracy being the requirement. Under the circumstances the iron-ship builder is put to one expense which the man who works in timber does not incur. He is compelled to employ fine engineering talent in his draughting room and mold-loft; with a good man in charge of that department of his business there is no trouble in building the ship. The value set upon accuracy is shown by the fact that good draughtsmen get $10 a day in the iron-ship yards, while the best mechanics receive no more than $3.

The art of building iron vessels is now well understood in the United States, and, whatever the class of vessel desired, it can be strongly and satisfactorily built, whether it be a river steamboat, a tug, a mud-scow, a steam-yacht, a sailing-yacht, a great paddle-wheel vessel for Long Island sound, a railroad car ferry, a coasting propeller, a steamship for the foreign trade, a large sailing ship, or an iron-clad man-of-war. American builders seem to have learned their art by intuition. The workmen are recruited principally from the machine and boiler shops, but a number have also been obtained from the old wooden-ship yards. A ship-carpenter makes as good a man for the iron-ship yard as does the boiler-maker, and with the aid of a very few machinists any wooden-ship builder could transfer his whole working force from wood to iron and in six months' time have as competent a set of men as he would require.

As the material for an iron ship is ordered in exactly the lengths and sizes required, angle-irons for the frames, beams, keelson pieces, stringers, etc., seldom have to be trimmed, as their lengths can be accurately ascertained from the draughts of the vessel and the mold-loft floor. The stem- and stern-posts are forged in accordance with measurements furnished, aided by a flat wooden mold. The outside plating is ordered from a wooden model of the vessel, which is made for the purpose, on whose surface the strakes of plates are accurately drawn with a lead-pencil. A small fraction of an inch is allowed in the length, so that they will not be too short, and the surplus is taken off by shearing and planing the edges; and while there is some other shearing, planing, and trimming of iron in the various parts of the vessel, the waste of material is so small as to form no appreciable item in the cost—a fact in striking contrast to the situation in a wooden-ship yard, where not less than one-fourth and often fully one-half of the timber is wasted in making the vessel. As the weight of iron is definitely known, great accuracy of estimate is possible in calculating the quantity and cost of materials. In ordering plating, for instance, the convenient rule is followed that a square foot of rolled iron one inch thick weighs 40 pounds. The real average weight is 40.28 pounds; but the rule of 40 pounds to the square foot is so close, that in buying the plating for a large vessel the weight may be previously known to within about one-fiftieth of the whole amount. The total weight of the angle-irons is closely calculated from the sizes, and can be approximated at any rate to within about one-fiftieth; the rule of ordering by width of flanges, so many pounds to the foot, allows of a perfectly accurate calculation, and this is the method preferred. The following are the sizes and weights of angle-iron rolled by the Phœnix Iron Company at Phœnixville, Pennsylvania:

Width of flanges and thickness of the iron.	Range of weight per running foot.	Width of flanges and thickness of the iron.	Range of weight per running foot.
Inches.	*Pounds.*	*Inches.*	*Pounds.*
1 x 1 x 1/8	0.83 to 1.13	3 1/2 x 3 1/2 x 5/16	8 1/3 to 12
1 1/4 x 1 1/4 x 1/8	1 to 1 1/3	3 1/2 x 4 x 3/8	9 to 13
1 1/4 x 1 1/2 x 3/16	1 1/2 to 2 1/3	3 x 4 1/2 x 3/8	9 to 13
1 1/2 x 1 1/2 x 3/16	2	3 x 5 x 7/16	10 to 14
1 3/4 x 1 3/4 x 5/32	2 to 3 1/3	3 1/2 x 5 x 3/8	11 2/3 to 15
2 x 2 x 1/4	3 to 4	3 1/2 x 6 x 3/8	11 1/3 to 16 2/3
2 x 3 x 1/4	4 to 5	4 x 4 x 7/16	11 to 16 1/3
2 1/4 x 2 1/4 x 1/4	4 1/3 to 5 2/3	4 x 5 x 3/8	12 1/3 to 17
2 1/2 x 2 1/2 x 7/32	5 to 7	4 x 6 x 3/8	14 to 17 1/3
2 1/2 x 3 x 5/16	5 1/3 to 8 1/3	4 x 6 1/2 x 3/8	14 2/3 to 20 2/3
2 3/4 x 2 3/4 x 1/4	6 1/3 to 8 1/3	4 1/2 x 4 1/2 x 1/2	14 1/3 to 18 1/3
3 x 3 x 11/32	7 1/3 to 9 2/3	5 x 5 x 1/2	16 to 20
3 x 3 1/2 x 3/8	7 2/3 to 11	6 x 6 x 1/2	19 1/3 to 25

BULB T-IRON BEAMS.

Width clear across the upper flange, depth of vertical flange, thickness of the same, and diameter of bulb.	Weight per running foot.	Width clear across the upper flange, depth of vertical flange, thickness of the same, and diameter of bulb.	Weight per running foot.
Inches.	*Pounds.*	*Inches.*	*Pounds.*
3 x 5 x 3/8 x 1 7/16	12 to 33 1/3	4 1/2 x 8 x 7/16 x 1 5/8	22 to 27
3 1/2 x 6 x 3/8 x 1 3/8	14 to 16	4 3/4 x 9 x 7/16 x 1 1/2	23 to 27
4 x 7 x 7/16 x 1 3/8	17 to 21	5 x 10 x 7/16 x 1 5/8	28 to 35
5 x 7 x 7/16 x 1 3/4	21 to 24	5 x 11 1/2 x 7/16 x 1 5/8	32 to 37

The raw material for iron-ship building is the finished product of the skilled labor of a rolling-mill, and this explains why the materials entering into an iron ship make about 60 per cent. of its cost; the labor bill is about 40 per cent. In a 1,200-ton sailing ship about 650 tons of finished iron would be used, in one of 2,000 tons about 850 tons, while in large ocean steamers of from 3,000 to 5,000 tons register from 1,300 to 2,000 tons of iron would be required for the hull and from 300 to 400 tons for machinery. In addition to iron, considerable coal and a certain amount of timber are consumed in the ship-yard. When a sailing vessel is built, the top gear is exactly the same as that of a wooden ship, except that hollow iron masts and yards are sometimes used. Allowing for all exceptions, even in sailing vessels the weight of iron used still constitutes almost the whole cost of the raw materials of the ship. It is difficult to state with exactness the price at which ship iron was sold to the builders in the census year. The supply came principally from the different rolling-mills in Pennsylvania, and the varying charges for freight to destinations in different states and the changing price of pig-iron affected the prices at which the several builders bought. Perhaps as fair an average as any are the following figures: Deck beams, curved to the crown of the deck, in 1880, 3.15 cents per pound; 1881, 3.1 cents per pound. Angle-iron, cut to length, 1880, 2.65 cents per pound; 1881, 2.55 cents. Plate iron, 1880 and 1881, average price 2.95 cents per pound.

Iron-ship building differs from the sister industry in the important respect that larger capital is required to carry it on. In the wooden-ship yard nearly all the workmen, to begin with, supply their own hand tools, and after the outfit of broad-axes, adzes, saws, bevels, chisels, calking-irons, mallets, rules, etc., is thus provided, little remains for the builder to purchase except a bolt-cutter, a few planking screws, a few large augers for boring bolt and treenail holes, a derrick, and a large cross-cut saw. Even if he supplies the yard with steam-power, a bevel saw, and a planer, it is hard for him to spend more than $15,000 or $20,000 on his plant, and he can build the largest wooden ships without them. There are plenty of builders of large wooden vessels in the country whose outfit of tools does not exceed $500 in value. On the other hand, an iron-ship yard cannot be established for a smaller investment than about $60,000, and for a large business the investment is anywhere from $200,000 to $1,000,000. The following is a careful estimate of the plant required for a yard having a capacity of one ship of from 2,000 to 2,500 tons a year:

One pair of rolls	$4,000	Hand tools	$2,500
Three punching machines	3,000	Engine, boiler, pumps, etc	4,000
One pair of shears	1,200	Shafting and pulleys	5,000
One planer	2,000	Blacksmith-shop and fittings	3,000
Two countersinks	1,500	Cranes and railways	3,000
One drill	800	Buildings, wood	10,000
One lathe	700	Foundations	4,000
One furnace	2,500	Sundries	5,000
One frame-bending slab	1,500		
Small tools	2,500	Total	57,200
Steam hammer	1,000		

This circumstance of the greater cost of plant limits the number of iron-ship yards which can exist in a country.

With reference to model, it should be stated that the change from wood to iron produces the effect of narrowing the beam of ships. The one weak place of the iron hull is the flat of the floor, which, on account of the thinness of the material, tends to buckle and collapse. This is offset to some extent by the use of vertical plates from 15 to 30 inches deep, according to the tonnage of the vessel, extending across the floor on each frame from bilge to bilge. These floor plates are strongly riveted to the upper edge of the frame angle-iron; the reverse angle-iron, which is riveted to the back of each frame, leaves the frame at the bilge and runs across the upper edge of the floor plate, being strongly riveted thereto. The floor plate, the angle-iron, and the reverse angle-iron united constitute the frame, which, while of narrow molding on the sides of the vessel, is thus of considerable depth across the floor. But even this is not enough. It has been considered safer by all builders of iron vessels, especially of sailing craft, to make the floor sharper, so as to give it a little more vertical stiffness, and then to narrow the beam a few feet. In order to gain the same register tonnage the hull is made longer. This narrowing of the beam makes the vessel swifter, both in the case of sailers and of propellers, which is an advantage, and its only drawback is that in sailing vessels it makes the ship crank. The center of gravity of an iron hull is always higher than in a wooden one, and the model aggravates the evil. The beam of an iron sailing ship is from 2 to 5 feet narrower than in a wooden one. The following comparison between average craft of the same tonnage will show the difference:

IRON SAILING SHIPS (ENGLISH).				WOODEN SAILING SHIPS (AMERICAN).		
Tonnage.	Length on deck.	Broadest beam.	Depth of hold.	Length on deck.	Broadest beam.	Depth of hold.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1,000	220	34	21	177	36	23
1,200	220	35½	21	186	37	23
1,300	230	36½	23	194	38	24
1,400	245	37	22	200	39	24
1,500	248	37⅜	23	215	40	24
1,600	253	38	23	220	40½	24
2,000	270	38	32	235	43	27

A description will now be given of the various localities in the United States where iron-ship building is or has been carried on and of the classes of vessels built. Any extended reference to the war ships built from 1861 to 1865 will, however, be omitted, as foreign to the purposes of this report.

North of Massachusetts, on the Atlantic coast, no production of iron merchant vessels has yet been reported.

An iron vessel was built in Boston as early as 1841. Jabez Coney, an iron manufacturer, paid some attention to ship-building, and obtained a contract for the revenue-cutter Saranac. It is believed that this was the first iron vessel in New England. Probably others were constructed in the following ten years, but none of large size. In 1853 the Atlantic works were incorporated by a special charter, and shops were established in East Boston with all the facilities required for engine- and ship-building. In their early history these works built almost entirely on foreign orders. They made engines for the Russian corvette Mandjoor, Le Voyageur de la Mer, a steamer for the Pacha of Egypt, and the Paraguayan steamer Argentina, and also built several steamers complete for the Russians and Chinese, one for the Sandwich Islands, and for American owners the composite steamer Niphon and the iron steamer Pembroke, the latter being afterward sold to go to the East Indies. In 1861 the works devoted their whole attention to United States government business, and built the iron-turret monitors Nantucket and Casco, the turrets for the Monadnock, Agamenticus, Passaconaway, and Shackamaxon, and the engines for five naval steamers. Since the war these works have built much machinery on government orders, two iron revenue-cutters complete, the Richard Rush and the Samuel Dexter, and the noted United States dredge-boat Essayons, which did service at the mouth of the Mississippi river. One of their vessels was the steamer William Lawrence, of 1,049 tons, for the trade between Boston and Baltimore, in which she is still running. An iron sailing vessel, the brig Novelty, was also built by them after the war for the transportation of molasses in bulk; the hold of the little vessel was completely lined with cement for the purpose. The works occupy four acres of ground, and the equipment is complete. Iron vessels could be undertaken at any time; but of late years little has been done except the construction of machinery for ferry-boats, yachts, excursion boats, etc., and the repair of iron vessels, and it must be said that, so far as the latter branch of the work is concerned, the port of Boston now supplies the yard with very little to do. Iron steamers throng the port, but they are all of foreign build and ownership, and display an indisposition to having work of any kind done on this side of the ocean that can possibly be avoided.

Le Voyageur de la Mer was built under a contract with George A. Stone, a young man who had been for several years a resident of Syria as a representative of a Boston commercial house. He was something of an engineer, and in an interview with the Pacha of Egypt he obtained a contract from him to build a ship. The steamer was 216 feet long, 37 feet on the beam, and 22 feet deep in the hold, and registered 1,300 tons. The plates and frames were rolled in Norristown and Philadelphia, Pennsylvania, machinery being put up in Boston for cutting, punching, and molding them. The hull required 3,000 plates and 300,000 rivets, a total weight of 881,000 pounds of iron. The steamer had an inner wooden frame of great solidity ceiled with pitch-pine, two flush decks, and five water-tight iron bulkheads, two extending to the upper deck. The boilers were four in number, and oscillating engines of 800 horse-power were put in, which were 54 inches in diameter, with 3 feet stroke. The propeller shaft was 13 inches in diameter, and carried a $15\frac{1}{2}$-foot wheel. This was one of the very first large iron boats in the United States.

In South Boston there is a yard in which 850 men can be employed, and there is a rolling-mill in the immediate vicinity. There are two large ship-houses on the grounds, a machine-shop of granite 300 feet long, various other buildings, and a derrick which will handle a weight of 60 tons. About $200,000 are invested in the property. The yard was established in 1857 by Harrison Loring, a young man who had had experience in making stationary and marine engines and industrial machinery, and who in 1841 had worked in the ship-yard of Jabez Coney on the iron revenue-cutter Saranac. Mr. Loring's first boat was the Sestos, for the East Indies, a small steamer, the plans for which were prepared in England. The owners were pleased, and Mr. Loring built for them a sister boat. In 1860 he built two iron steamers of 1,150 tons each for the trade between Boston and New Orleans, but they were afterward sold to the government for employment in the blockading fleet. The iron propellers Mississippi and Merrimac, each of about 2,000 tons, were built in 1861, and afterward the monitor Nahant, the ram Canonicus, and the side-wheeler Winnipee, of 1,500 tons. Since the war the works have been devoted to machinery for sugar and paper factories. All the facilities exist for the construction of vessels. Mr. Loring regards American iron as the best for ship-building, on account of its superior tensile strength, and has repaired English-built vessels whose plates were so weak as not to have over one-half the tenacity of common cast iron. He states that Mr. Martell, the surveyor for Lloyds at Liverpool, admitted to him the necessity in England for something better than their rolled iron for plates, and the consequent adoption by them of steel for ship-building. The South Boston yard labored under the disadvantage of city rates of wages.

In a city like New York iron-ship building naturally began early. An immense amount of every kind of tonnage was built and owned there, and everything which related in any way to ships was eagerly studied by both builders and owners. Builders were enterprising, and watched with especial interest what was going on in England. After iron vessels began to be built in Liverpool and Glasgow the subject was considered in New York. In the years from 1830 to 1850 quite a number of iron steamboats, revenue-cutters, and tugs were constructed, and builders became familiarized with the idea of iron frames and iron shells for ships. In 1839, as already noted, the little iron propeller New Jersey, 70 feet long, 10 broad, and $6\frac{3}{4}$ feet deep in the water, arrived from England, on Commodore Stockton's order, to go on the Delaware and Raritan canal and the rivers Delaware and Schuylkill as a tug.

In 1858 there was quite a movement toward building iron vessels. The steamer Suchil, a side-wheeler, was launched from Bell's yard, on the East river, with 200 people on board. She was 140 feet long, 35 feet beam, and $5\frac{1}{2}$ feet deep in the hold, with three bulkheads and two 120 horse-power engines, and was launched in 43 days from the laying out of the iron plates for the keel on the building-ways. There were 250 tons of iron in her hull. She drew 12 inches light after launching and 16 inches with everything on board, and was ordered by the Tehuantepec Company to run on the California route from New Orleans via the Coatzacoalcos river. Her hull was modeled at the ends for a speed of from 10 to 12 miles per hour. In the same year the Novelty iron works built a steamboat 168 feet long and 30 feet on the beam, while the Morgan iron works began on a contract for four iron propellers to go to Siam. It was in this period that New York was building so many large and handsome wooden steamers for the coasting and California trades. The cost of iron vessels of that size was estimated with a view to competing for the orders of the companies, but the excessive expense and the lack of large plant defeated all efforts to introduce them.

In 1861 William H. Webb built the iron-clad propeller frigates Re d'Italia and Re Don Luigi de Portugallo for the Italian government. The contract for them had been entered into before 1861, and some trouble was experienced in completing them, but the work was finally accomplished, and the ships were sent across the ocean and delivered. The Re d'Italia was $282\frac{1}{4}$ feet long on the upper deck from the after side of the rudder-post to the forward edge of the hawse-pipes. The breadth of beam on the load-line was 54 feet, and the total depth of hold $33\frac{1}{2}$ feet. The Re Don Luigi de Portugallo was 3 feet shorter. The armor of these vessels was mounted on a frame of oak and locust of the most massive description, and the weight of each ship with everything on board, including armament, was 6,150 tons. Each was capable of a speed of from 15 to 17 knots per hour. The Re d'Italia made 14 knots on her first trip with steam up in only four of her six boilers.

A monster iron-clad was soon afterward built by Webb and sold to the French government. Originally ordered by Secretary Welles for the United States service, she was not completed until the war was over. Her builder then obtained permission to sell her abroad, and she was sold to France. This ship was called the Dunderberg, but was rechristened the Rochambeau after her sale. She was a long and powerful ram, lying low in the water, but with a high shot-proof casemate amidships for the working of the guns. The extreme length was 380 feet, the beam of the hull on the plank-sheer $59\frac{1}{2}$ feet, the beam over all above $72\frac{5}{6}$ feet, and the depth of hold amidships $22\frac{5}{6}$ feet, with a casemate $7\frac{3}{4}$ feet high inside, superimposed. The portion of the bow which formed the ram was 50 feet in length. Mr. Webb gave this ship an almost perfectly flat floor, so as to gain the largest possible displacement. The dead rise was only 4 inches. The hull was massively built of wood, with armor above of $4\frac{1}{2}$-inch iron. The frames were spaced 3 feet, and molded over the keel 17 inches, at the floor-heads 14 inches, above the bilge 13 inches, and at the plank-sheer 9 inches. The sides of the casemate were 3 feet thick, and were set at a slope of 35°, to compel the glancing of shot. A thousand tons of iron were used in the armor, and the displacement was about 6,900 tons. This weight was carried on 21 feet draught. The ship's engines (two in number) were built by John Roach & Son, and developed 5,000 horse-power, giving a speed of $15\frac{3}{4}$ miles per hour. This ship registered 5,090 tons, and was the fastest armed steamer in the world at that time.

Since the war it has not been practicable to carry on iron-ship building in New York city. There are four large engine-shops which are devoted almost entirely to marine work, one of them, the Morgan iron works, belonging to Messrs. John Roach & Son, who build at Chester, Pennsylvania; but the building of hulls in New York has ceased, prices, wages, and taxes being too high for that class of work.

The only place on the Hudson which has an iron-ship yard is Newburgh, where Ward, Stanton & Co. have lately added the construction of iron vessels to their old business of building and repairing wooden river boats. In the census year the river propeller ferry-boat City of Catskill, of 414 tons, and a tug of 115 tons were built. Another ferry-boat, the Hoboken, about 190 feet long and 40 feet beam, a double-ender with side-wheels, and a screw yacht for James Gordon Bennett, 246 feet long over all, 225 feet on the keel, 26 feet beam, and 18 feet deep, were in process of construction. The cost of tugs at this yard is about $200 per ton.

At Camden, New Jersey, on the Delaware river, there is one well equipped yard devoted to the construction of tugs and pilot-boats with compound engines and vertical keels. This yard has been established for many years, and has had its ups and downs; but it has now proved the superior excellence of iron hulls for tugs, and builds four or five of that class of boat every year, there being usually two or three under way at once. Two of the boats built here were the Brazil, of 120 tons, 105 feet long, 20 feet beam, and 11 feet deep in the hold, with compound engines having 18- and 30-inch cylinders and 22-inch stroke, and the Juno, of 84 tons, 85 feet long, 18 feet beam, and 9 feet hold, with compound engines 15 and 26 inches in diameter and 20-inch stroke. These boats were sent to Brazil and encountered rough weather on the passage, but behaved so well as to prove their fitness for any ocean voyage. The Inca, another of their tugs, was also a seaworthy boat. The first iron pilot-boat in the United States was built here for service at New Orleans. She was named the Jennie Wilson, and registered 77 tons. In 1880 another of the same class was ordered, also for New Orleans, and was sent to her destination the next winter. The second boat was the Underwriter, of 170 tons, $120\frac{2}{3}$ feet long, 22 feet beam, and 12 feet deep, sharp on the floor, keen in the bow, with a good deal of sheer, and handsome in her whole bearing. The engines were compound, with 20- and 36-inch cylinders and 28-inch stroke, driven by a boiler 11 feet long and 11 feet in diameter, and the wheel was 9 feet in diameter, weighing 3,847 pounds. In an ordinary tug the only house that is needed is one amidships to shelter the boiler and engines and make room for the stowage of spare cables, etc. There must also be a little pilot-house either atop or forward. In the pilot-boat, however, more cabin space is necessary. The arrangement on the Underwriter was as follows: Forward there was a pilot's cabin; next aft was the engine-room, large and airy; then a dining-room, with kitchen and pantry adjoining; and finally, farthest aft, the lodgings of the pilots, having 16 berths. The forward hold was fitted up with 10 bunks for the crew. The plating was of $\frac{7}{16}$-inch iron. Weight of boat, with all on board except coal and water, about 175 tons. In the census year this yard built four iron tugs—the Inca, 103 tons; the Phœnix, 95 tons; the Kate Jones (Fig. 63), 123 tons; and the Nellie, 61 tons—consuming 385 tons of iron in the four hulls and machinery. They were completed at a cost of $76,000, about $200 per register ton, or not much more than the cost of the same class of vessel well built of oak and pine. Wages in the yard were $10 and $12 per week for all the iron-work hands and $15 for carpenters. A tug 120 feet long was building, at the time the yard was visited, with plating of $\frac{6}{16}$-inch iron, rolled 10 feet long, 3 and $3\frac{1}{2}$ feet wide; frames, $3\frac{1}{2}$- by $3\frac{1}{2}$- by $\frac{3}{8}$-inch angle-iron, spaced 20 inches; beams, angle-iron; and rudder- and stern-posts of $2\frac{1}{2}$- by 6-inch iron. An average of 50 men find employment in the yard, but it could employ 200.

Philadelphia, from its nearness to the iron and coal mines and from the remarkable development of the iron-manufacturing industry in the towns lying back of and around her, has always enjoyed a great advantage in iron-ship building. The city has a large number of engine-building works, and is exceptional in the cheapness of her iron and coal. It was natural that she should take a lead in iron-ship building the moment the industry had reached a point where the price of materials and convenience of access to rolling-mills near by should begin to tell. It has already been noted that the first iron vessel in America was a light-draught river boat which was launched in 1825 for use upon the Susquehanna. One of the earliest iron boats of which there is any record in Philadelphia was a small barge, which was built by Jesse Starr four squares from the river and was hauled down to the water by horses. In the thirty years following 1825 quite a number of small iron vessels were built in the city—steamboats, revenue-cutters, etc.—I. P. Morris, James T. Sutton & Co., and Neafie & Levy building from time to time, the hulls being designed and laid down on the mold-loft floor by practical ship-carpenters. It does not appear, however, that the product of the industry was so large and important as that at New York until after the beginning of the war of 1861. The outbreak of hostilities being a signal for preparations in Philadelphia for large ships, William Cramp fitted up at once his wooden-ship yard (where since 1830 he had built 106 vessels of different kinds)

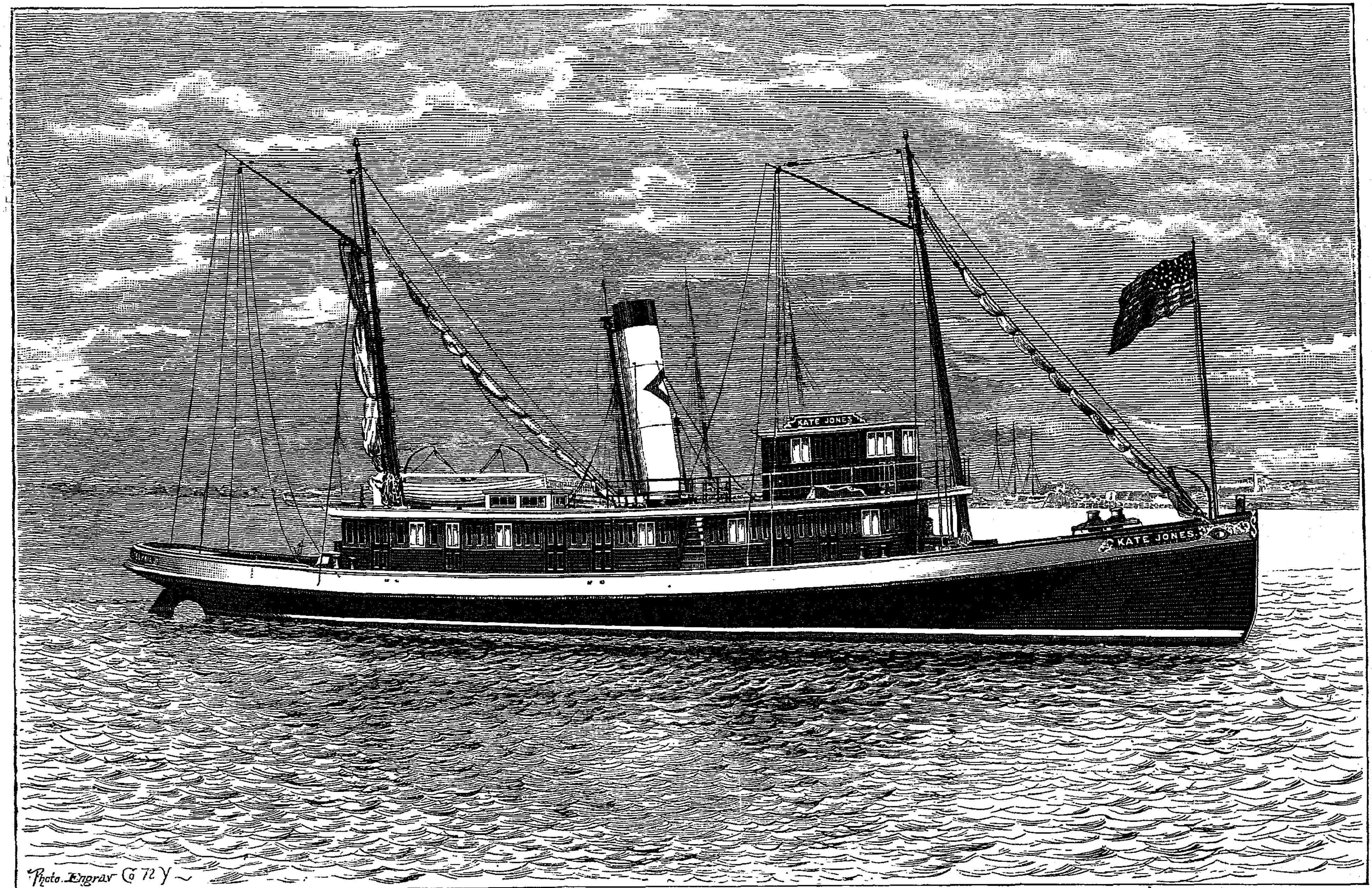


Fig. 63.—Tug Kate Jones.

Large cylinder, 30 inches; small cylinder, 18 inches; length, 109 feet; breadth, 20 feet; depth, 10 feet.

with machinery for the handling of iron plates and frames. His first vessel was the United States man-of-war New Ironsides, of 3,250 tons, 230 feet long and 56 feet beam, which was a strong wooden ship iron-clad above the water. She was built before the yard had been fully fitted up with machinery, and the armor plates were purchased from another concern. When the contract was made the timber for her frame was still growing in the woods; yet in six months' time she was launched and on her way to Charleston. Mr. Cramp afterward built the monitor Yazoo, the steamer Chattanooga, and a number of transports, and did a large amount of other government work. Meanwhile he was steadily improving the plant of the yard, and after the war it became one of the great iron-ship building concerns of the United States. When the building of war vessels ceased attention was turned to the subject of merchant steamers. Philadelphia had lines of coasting steamers to every port on the Atlantic and Gulf seaboard. They were old wooden boats, with a capacity seldom, if ever, exceeding 1,000 register tons, and were in part side-wheelers; as fast as they wore out they could be replaced by iron vessels, provided good ones could be built at not too great an increase of cost. The needs of the coasting trade were carefully considered, and a number of small iron steamers and tugs were built at the yard. Two propellers were built for the Clyde lines, and then, in 1872,

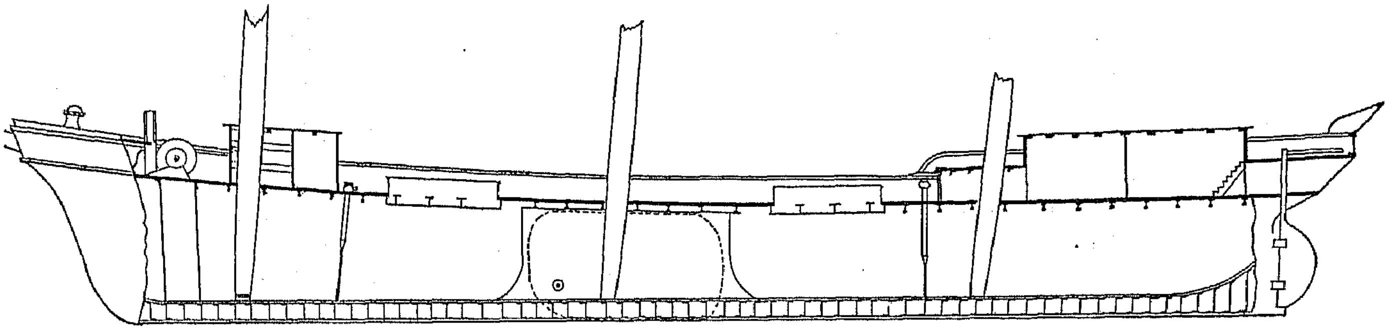


Fig. 64.—Longitudinal section of the three-masted schooner Josephine.

Built by William Cramp & Sons, Philadelphia. Length on deck, 132 feet 3 inches; length on load water-line, 126 feet; breadth, molded, 34 feet; depth, molded, 12 feet; depth of hold in the clear, 9 feet 10 inches.

Mr. Cramp obtained the contract to build four steamers for the new American line to Liverpool of 3,016 tons each, at a total cost of $2,400,000. These boats made the reputation of the yard, and there being then no American steamers in the trade from the United States to Europe (and indeed there have been none since) it was deemed important to construct them in good style as specimens of American workmanship. They were modeled long and narrow, with fine bows and runs and slightly hollow water-lines. The dimensions of each were: Length over all, 355 feet; breadth of beam, 43 feet; depth of hold, 35 feet. Decks, 3 in number; 2 masts. Each ship was supplied with two compound 1,800 horse-power engines, with 57- and 90-inch cylinders, having 4 feet stroke, and a 16-foot wheel. The ships were completed in 1873, and proved fast, smart, and strong vessels; their speed was 13 miles an hour. They have now been running nine years, and are insured by English companies at the most favorable rates given to any iron vessels afloat. As passenger boats they fully answered all expectations; their average time from cape Henlopen to Queenstown is 9½ days, and on the return 10 days 2 hours. Each carries 100 cabin and 800 steerage passengers, 1,740 tons of cargo, and 720 tons of coal on 20½ feet draught of water. The export trade to Europe now requires steamers which can carry 3,000 tons of cargo, but in the day when they were built the American boats did all that was demanded of them.

After the American line was built this yard gave its attention wholly to the production of iron tonnage. Down to the present year the yard has constructed in all more than 50 vessels (the majority of them for the coasting trade), including a few yachts and the conversion of four fast steamers into men-of-war for the Russian navy. When the Russian contracts were being fulfilled the yard was so busy that it was compelled to employ a number of shops outside to aid in the work. The propellers made by the Cramps are characterized by long, keen, wedge-like bows, rising floors, good speed, and strong workmanship. The yachts Corsair and Stranger, which were finished in 1880, were sisters, 165 feet long, 23 feet beam, and 13 feet deep in the hold, and weighed complete, with all on board except coal and water, about 270 tons each. One of the vessels finished in 1880 was the coaster Chalmette, for the New Orleans trade, 338 feet long, 42 feet beam, and 31 feet hold, and of 2,983 tons register—a fast and handsome vessel. Three steamers were on the stocks in 1880, and there were contracts for others. The Cramps do a large business in repairing, a branch of work which is valued by all iron-ship builders as being the most profitable. In new vessels the proportion of labor to materials is as 40 to 60 per cent., whereas in repairing the proportion is as 65 to 35 per cent.

The Cramps have two establishments. At one of them, at the foot of Norris street, the ships are built. It is a large yard 600 feet wide by 700 deep, with a number of shops for the bending, shearing, and punching of frames and plates, the forging of bars and shafts, and the making of boilers and engines, and with five building ways and ample wharf and dock room. Plates and frames are ordered from rolling-mills at Johnstown and Phœnixville, Pennsylvania. The other establishment is at the foot of Palmer street, fronting 230 feet on the river, and extending back 620 feet. It has a machine- and blacksmith-shop for repair work and a basin dry-dock 462 feet long, 111 feet wide on top, and 23 feet draught of water. In making this dock 4,200 piles were driven. The pumps are centrifugal, four in number, with a joint capacity of 30,000 gallons per minute, and empty the dock in 45 minutes. The regular force of the company is 1,200 men, but in busy years 3,000 men can be employed. The working force of 20 wooden-ship yards is concentrated in these two establishments.

Only one iron sailing vessel has ever been built by the Cramps. This was the center-board schooner Josephine (Figs. 64 and 65), of 365 tons, 126 feet long on the load-line, 132½ feet over all, 34 feet beam, and 12 feet molded depth,

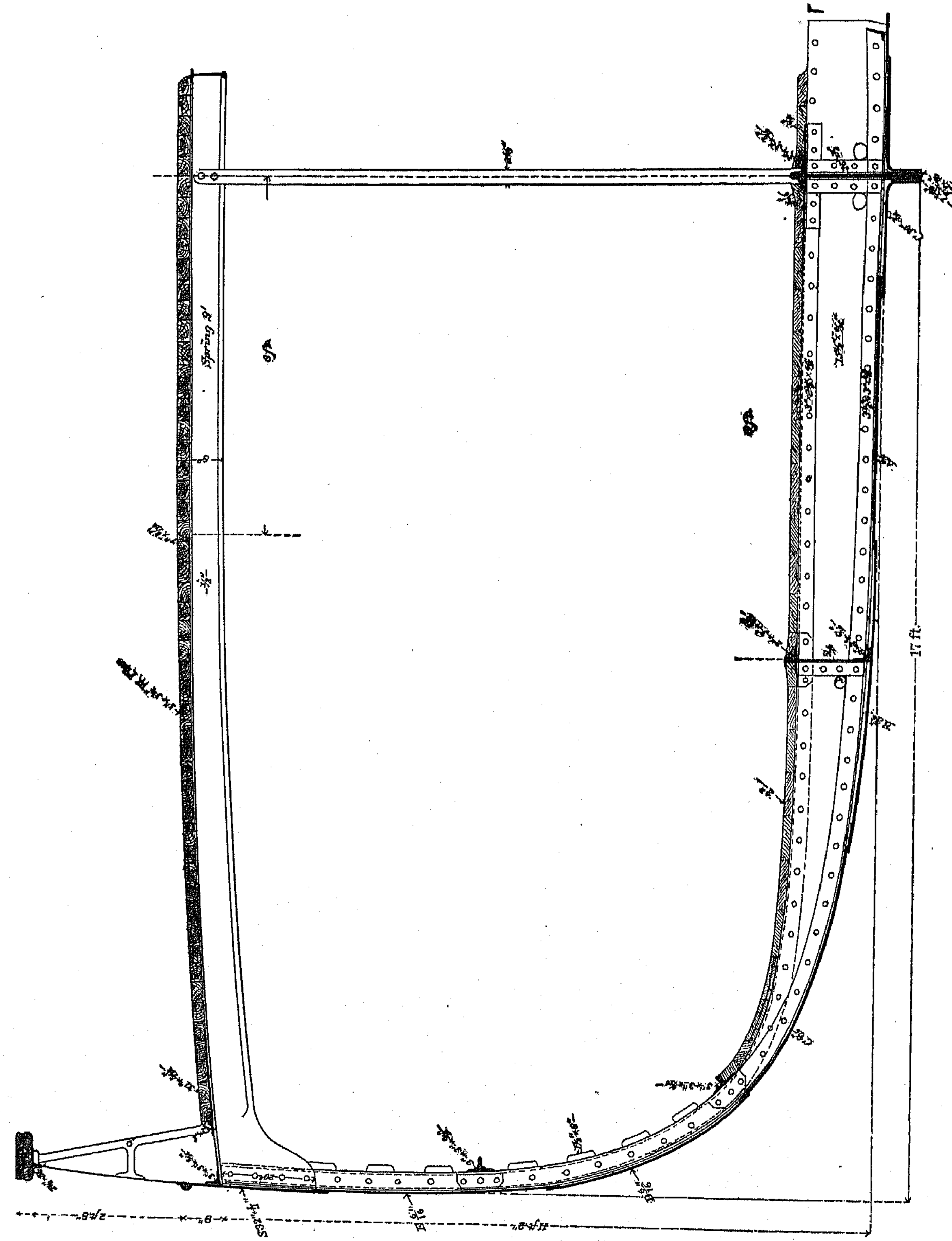


Fig. 65.—Cross-section of Iron Schooner Josephine.

the hold being 9⅚ feet deep in the clear. This vessel was the idea of a number of shipwrights and maritime people in Philadelphia, the most of them owners in other craft. John Main had had a small iron steamboat built by the Cramps, and thought that if a sailing vessel could be built with a hull something like that it would be a success. He enlisted the interest of several associates; the vessel was ordered, and was completed at a cost of $96 per register ton, or about $8,000 more than a wooden center-board schooner of the same capacity. She ranked as

A 1 for 16 years, however, and the owners expect to save that $8,000 more than once during her existence in escaping from the necessity of the continual calking and repair to which wooden vessels are subject. The scantling of the schooner is as follows: Keel, vertical center plate, 26 inches wide, $\frac{1}{2}$ inch thick; vertical side plates, below the frames, 7 inches wide, $\frac{3}{8}$ inch thick; frames, angle-iron, $3\frac{1}{2}$ by 3 inches by $\frac{6}{16}$ inch; reverse angle-iron frames, 3 by $2\frac{1}{2}$ inches, $\frac{5}{16}$ inch thick; spacing, 20 inches; floor plates, 15 inches deep over the keel, $\frac{1}{2}$ inch thick, extending from bilge to bilge, riveted to the vertical center plate by short angle-irons; on top of the frames, at each side of the center plate, there is riveted a continuous flat plate, fore and aft, 10 inches wide, $\frac{3}{8}$ inch thick, which is tied to the keel plate by continuous angle-irons, 3 by 3 inches by $\frac{6}{16}$-inch thick. This arrangement constitutes the main keelson. Eight feet each side of the main keelson is placed an intercostal side keelson, made of $\frac{5}{16}$-inch plates, rising 3 inches above the floors, and secured by fore-and-aft angle-irons, 3 by 3 inches and $\frac{3}{8}$ inch thick. There is a bilge keelson each side, composed of two angle-irons, same as the above, laid on the frames, and riveted back to back. Half way up the sides of the hold there is a stringer of two angle-irons, similarly arranged, and of the same size. Beams of bulb T-iron, 7 inches wide on top, 8 inches deep, and $\frac{1}{2}$ inch thick, spaced every other frame. A stringer plate over the ends of the beams is 31 inches wide and $\frac{3}{8}$ inch thick. The tie plate is 7 inches by $\frac{3}{8}$ inch thick. There are 7 streaks of outer plating. The garboards lap 7 inches on the keel, are riveted clear through, and are of $\frac{7}{16}$-inch iron. The next strake is $\frac{6}{16}$ iron; the next, $\frac{7}{16}$; and all the rest $\frac{6}{16}$, except that the sheer strake is $\frac{1}{2}$ inch. The bulwark plating is $\frac{1}{4}$ inch. The hold is floored with 2-inch yellow pine, the deck with $3\frac{1}{2}$-inch white pine, and there is one bulkhead in the bow. The total weight of metal in the hull was 225 tons. On the whole, the scantling of this schooner would be considered a little light, but this is due to the superior quality of American iron. On deck the arrangement was the one which is customary in schooners. Forward there is a house $6\frac{1}{4}$ feet high and 11 feet long, through which rises the foremast. There is also a small top-gallant forecastle for the windlass. Aft there is a poop-deck, on which there is a house 23 feet long, with quarters for the officers. The schooner spreads 3,150 running yards of canvas. She is a good carrier, taking 550 tons of cargo at a trip, and is regarded as a successful vessel. She would be followed by others of the same class except for the first cost. (*a*)

The firm of Neafie & Levy, in Philadelphia, has been engaged in the construction of iron vessels of small size since 1844. This firm came into existence in 1838, and built its first vessels in 1844. The product of this establishment has been principally engines and propeller wheels. Up to the fall of 1882 it had built and put into vessels no less than 737 engines. Its propeller wheel is a specialty, the manufacture of which has grown into a large business. About 350 per year are now produced, varying from $2\frac{1}{2}$ to 15 feet in diameter, and are sent out all over the country. The firm takes contracts for both wooden and iron hulls. The latter are built upon its own grounds, but the wooden craft are generally constructed by a subcontractor. The following is the list of iron vessels built by this firm:

Name.	Year.	Length.	Breadth.	Depth.	Name.	Year.	Length.	Breadth.	Depth.
		Ft. In.	*Ft. In.*	*Ft. In.*			*Ft. In.*	*Ft. In.*	*Ft. In.*
Conestoga	1844	80 0	16 0	6 0	General Scott	1860	225 0	32 0	10 0
Barclay	1844	125 0	20 0	6 0	Union	1860	225 0	32 0	10 0
Tecumseh	1844	85 0	8 0	3 6	Russia	1860	75 0	15 6	7 0
Apure	1844	160 0	23 6	6 0	Siberia	1860	75 0	15 6	7 0
San Juan	1844	110 0	14 0	3 6	Amoor	1860	75 0	15 6	7 0
Rancocas	1844	125 0	16 6	6 6	Van Vliet	1862	75 0	15 6	6 6
Montezuma	1852	60 0	10 6	3 6	Joseph Thompson	1862	158 0	23 0	8 6
Gov. Moorhead	1852	100 0	17 6	3 0	General Meigs	1862	158 0	23 0	9 6
Orinoco	1852	115 0	23 0	8 0	Pocahontas	1862	160 0	30 0	9 0
Decatur	1855	65 0	15 0	5 6	Charles Pearson	1863	130 0	26 0	14 0
Bordman, No. 1	1855	125 0	19 6	7 0	Havana	1863	230 0	34 0	24 0
Bordman, No. 2	1855	100 0	19 0	6 0	Dashing Wave	1863	60 0	18 0	4 3
Jacob G. Neafie	1856	80 0	19 6	7 0	Julia Saint Clair	1866	129 0	37 0	4 0
Major Brewerton	1856	91 0	19 6	7 6	Bandy Moore	1866	129 0	37 0	4 0
Fanny Cadwallader	1856	158 0	23 8	8 0	Ida	1870	65 0	15 0	6 0
Elizabeth	1856	158 0	23 8	8 0	Seminole	1871	80 0	18 0	8 0
James Gray	1857	85 0	18 0	8 0	Cynthia	1871	95 0	18 0	8 0
Sagua	1859	120 0	24 0	6 0	Mary Louisa	1871	86 3	18 0	8 0
Octarara	1859	158 0	23 8	8 0	W. E. Gladwish	1873	118 0	24 0	9 0
Philadelphia	1859	200 0	20 0	9 0	Sallie	1872	60 0	13 0	6 0
Pacific	1859	75 0	15 3	6 6	Tisdale	1872	98 0	18 0	8 0
William Woodward	1860	158 0	23 8	8 0	Alfred and Edwin	1872	100 0	21 0	7 0
Ounalaska	1860	75 0	15 6	7 0	J. G. Witterbee	1872	108 0	20 0	9 0
Arasapha	1860	120 0	25 0	8 6	Ethel	1872	60 0	14 0	6 0
Oriental	1860	210 0	32 0	20 8	Convoy	1873	85 0	19 0	9 3

a During the winter of 1882–'83 there has been established in Philadelphia one new yard. Some repair shops in the northern part of the city, owned by the Reading railroad and originally intended for iron-ship building, but never used for that purpose, have been bought by a company of New York men. They are to be placed under the management of Lieutenant Gorringe, late of the United States navy, and a contract has been taken for a sailing ship, which it is at present proposed to construct during 1883.

Name.	Year.	Length.	Breadth.	Depth.	Name.	Year.	Length.	Breadth.	Depth.
		Ft. In.	Ft. In.	Ft. In.			Ft. In.	Ft. In.	Ft. In.
Dahlia	1874	141 6	25 0	10 6	Conoho	1881	170 0	23 6	9 0
William S. Stokeley	1874	100 0	18 0	8 6	W. M. Wood	1881	80 0	17 0	8 0
Ivanhoe	1874	67 6	14 6	6 6	William T. Hart	1881	294 6	42 0	13 0
Startle	1876	60 0	14 0	6 6	Battler	1881	110 0	22 0	11 0
Transfer, No. 1	1877	100 0	21 0	10 0	William A. Marburg	1881	105 0	21 0	9 6
Cuba	1878	211 0	32 6	21 6	Nat Wales	1881	85 0	18 6	9 0
Ella Andrews	1878	80 0	17 0	8 0	Storm King	1882	118 0	21 0	13 0
John E. Tygert	1879	115 0	22 0	6 0	City of Philadelphia	1882	100 0	19 6	11 0
Neptune	1879	115 0	20 0	6 0	Leo	1882	90 0	19 0	9 0
Rattler	1879	110 0	22 0	11 0	City of Alma	1882	110 0	20 0	5 0
Atlantic	1879	159 3	30 0	11 9	Rushing	1882	100 0	19 6	10 6
Transfer, No. 2	1880	100 0	21 0	10 0	Tyson	1882	176 0	23 6	10 0
George H. Watrous	1880	100 0	21 0	10 0					

At Chester, Pennsylvania, there is one large yard, the property of John Roach & Son, of New York. In 1868 the founder of this business, after a long experience as a boiler and machine builder in New York, had bought the Morgan iron works of that city, a large establishment at the foot of Ninth street, on the East river, in which most of his machinery has since been built. In 1872 Mr. Roach bought a large property at Chester and developed there a great iron-ship yard, his first vessel being launched in 1873. It has always been a busy yard, producing regularly not less than four and sometimes as many as ten large class steamers a year. The largest American steamships afloat came from these works. The yard itself is the most important one in the United States.

The plant at Chester is elaborate, complete, and of the very first order, and represents an investment of about $1,000,000. The works cover about seventy acres of ground, and have a front of 2,500 feet on the Delaware river. The river is over a mile wide at this point, with depth enough to float the largest steamer of the present day. Building slips have been substantially constructed on heavy piling, making accommodations for the building of ten large vessels at once, and the docks and wharves have been furnished with shears and hoisting engines for masting vessels and putting aboard the boilers and machinery. A short distance below the ship-yard proper, and located on the river bank, are the Chester rolling and steel mills and a blast furnace, the latter with a capacity of 700 tons per week. The furnace alone cost $250,000. These works are owned by the proprietors of the ship-yard, cover about thirty acres, and employ 800 men; and it is not too much to say that they constitute the best plant in the United States for making plates and armor of iron and steel and steel castings. It is an interesting fact that at these two establishments, owned by one firm, iron and steel ships can be created, beginning with the ore itself and ending with the finished steamer, completely equipped for sea. Every part of the work is done by the one firm, and it is believed that this is the only establishment in the world possessing such complete facilities.

In the ten years from 1873 to 1882, both inclusive, the total tonnage built by John Roach & Son aggregated about 148,000 tons, the average being 14,800 tons per year; the largest product in any one year 28,190 tons. The ollowing are some of the details concerning the vessels built:

Names.	Year when built.	Side-wheel or screw.	Length.		Breadth.		Depth.		Tonnage.	BOILERS.					ENGINE.	Wheel diameter.	
										Number.	Diameter.		Length.		Diameter and stroke.		
			Ft.	In.	Ft.	In.	Ft.	In.			Ft.	In.	Ft.	In.		Ft.	In.
City of Waco	1873	Screw	244	0	36	0	19	9	1,549	4	10	0	9	6	30 and 56 x 54	13	0
Erie	1873	Side-wheel	102	0	36	0	14	0	750	1	10	0	30	0	46 x 11	22	0
Colima	1873	Screw	312	0	40	0	29	3	2,906	4	13	0	9	9	51 and 88 x 42	16	3
Colon	1873	....do	300	0	40	0	29	3	2,714	4	13	0	9	9	51 and 88 x 42	16	3
Garden City	1873	Side-wheel	184	10	33	6	14	0	840	1	10	10	34	0	48 x 120	22	0
City of San Antonio	1873	Screw	232	8	36	0	22	0	1,450	2	14 13	9 9	10	6	48 x 48	13	0
George W. Elder	1874	....do	258	0	38	0	21	4	1,569	4	10	0	9	6	30 and 56 x 54	13	0
City of Guatemala	1874	....do	258	0	36	0	20	1	1,490	4	13	0	9	6	30 and 56 x 54	13	0
City of Panama	1874	....do	258	0	30	0	20	1	1,400	4	13	0	9	6	30 and 56 x 54	13	0
State of Texas	1874	....do	248	0	36	0	10	9	1,549	4	13	0	9	6	30 and 56 x 54	13	0
Berks	1874	....do	196	6	28	6	12	9	553	1	12 10	0 0	8	9	20 and 34 x 30	....	
Perkiomen	1874	Screw	219	5	37	0	15	9	1,035	2	10 11	3 2½	8	8	27 and 45 x 36	11	0
City of Peking	1874	....do	419	0	47	4	36	1½	5,080	10	13	0	10	6	51 and 88 x 54	20	3
City of Tokio	1874	....do	419	0	47	4	36	1½	5,080	10	13	0	10	6	51 and 88 x 54	20	3
City of Chester	1875	....do	206	6	33	6	15	10½	1,106	2	9 12	0 6	11	6	24 and 44 x 45	10	0
City of Sidney	1875	....do	352	0	40	0	29	0	3,017	6	13	2	10	6	51 and 88 x 60	20	0
City of San Francisco	1875	....do	352	0	40	0	29	0	3,019	6	13	2	10	6	51 and 88 x 60	20	0
City of New York	1875	....do	352	0	40	0	29	0	3,019	6	13	2	10	6	51 and 88 x 60	20	0

Names.	Year when built.	Side-wheel or screw.	Length.		Breadth.		Depth.		Tonnage.	BOILERS.					ENGINE.	Wheel diameter	
										Number.	Diameter.		Length.		Diameter and stroke.		
			Ft.	In.	Ft.	In.	Ft.	In.			Ft.	In.	Ft.	In.		Ft.	In.
Rio Grande	1876	Screw	308	0	39	0	21	0	2,566	4	11	10	10	0	34 and 60 x 54	14	0
Newbern	1876	....do	162	9	24	3½	9	0	846	......	......	......	......	......	24 and 36	8	0
Alert	1876	....do	190	9	32	0	15	0	1,246	5	8	0	8	1	28 and 42 x 42	12	0
Alliance	1876	....do	190	9	32	0	15	0	1,246	5	8	0	8	1	28 and 42 x 42	12	0
City of Savannah	1877	...do	272	0	38	6	24	6	2,029	4	12	8	10	6	38 and 68 x 54	15	0
City of Macon	1877	....do	272	0	38	6	24	6	2,093	4	12	8	10	6	38 and 68 x 54	15	0
City of Washington	1877	....do	320	0	38	0	27	7	2,618	......	18 20	0 7	18	0	40 and 74 x 72	16	0
Western Texas	1877	....do	239	7	34	0	16	0	1,121	2	10 8	3 6	10	0	24 and 44 x 44	11	6
Panama Railroad Tug	1877	....do	98	3	18	1½	6	0	75	1	10 8	3 6	9	11	20 x 24	6	9
Niagara	1877	....do	292	0	38	1	23	6	2,265	4	11	10	10	0	34 and 60 x 54	14	3
Saratoga	1877	....do	292	0	38	1	23	6	2,265	4	11	10	10	0	34 and 60 x 54	14	3
Gate City	1878	....do	272	0	38	6	24	6	1,997	4	12	8	10	6	38 and 68 x 54	15	0
City of Columbus	1878	....do	272	0	38	6	24	6	1,992	4	12	8	10	6	38 and 68 x 54	15	0
Saratoga	1878	....do	318	6	38	1	21	3½	2,426	4	13	6	10	6	40 and 74 x 54	15	6
City of Para	1878	....do	368	6	38	4½	28	7½	3,532	6	13	0	10	6	42½ and 74⅝ x 60	16	0
City of Rio de Janeiro	1878	....do	368	6	38	4½	28	7½	3,548	6	13	0	10	6	42½ and 74⅝ x 60	16	0
Oregon	1878	....do	300	0	38	1	23	6	2,335	4	12	8	10	6	30 and 60 x 54	15	0
Manhattan	1879	....do	246	9	35	3½	20	0	1,575	2	11 10	6 5	22	0	28 and 53 x 48	13	0
City of Alexandria	1879	....do	332	6	38	6	24	7	2,480	4	14	6	11	0	42½ and 78 x 54	16	0
Elias	1879	Side-wheel	173	4	27	3	8	2	240	2	7 9	4 0	13	2	26 x 72	19SW	
Santiago	1879	Screw	290	9	38	10½	22	0	2,359	4	13	3	11	0	38 and 68 x 54	15	0
Colorado	1879	....do	329	1	39	1½	21	0	2,765	4	13	3	11	0	38 and 68 x 54	15	0
Juan Mir	1879	Side-wheel	165	0	28	1½	11	0	425	1	10 9	6 2	11	0	28 x 36	9	9
City of Augusta	1880	Screw	......	......	......	......	......	......	2,870	......	......	......	......	......	42½ and 82 x 54	......	......
Yosemite	1880	... do	182	0	23	6	18	7	450	2	......	......	......	......	28½ and 40 x 33	......	......
Breakwater	1880	....do	225	0	35	0	20	0	1,045	......	......	......	......	......	38 and x 48	......	......
Newport	1880	....do	325	0	38	6	23	0	2,735	......	......	......	......	......	48 and 90 x 54	......	......
Columbia	1880	....do	310	0	38	0	23	0	2,722	6	......	......	......	......	42½ and 82 x 54	10½	
Louisiana	1880	....do	348	0	39	0	28	5	2,840						28 and 56 x 72		
Guadalupe	1881	....do	317	8	39	5	21	4	2,839						38 and 70 x 54		
Cygnus	1881	Side-wheel	212	6	31	4	11	8	857						53 x 144		
Cepheus	1881	....do	213	6	32	4	11	5	857						53 x 144		
Sirius	1881	....do	220	0	32	5	11	1	993						53 x 144		
Walla Walla	1881	Screw	310	0	40	6	22	2	2,131						40 and 74 x 54		
Umatilla	1881	... do	310	0	40	6	22	3	2,131						40 and 74 x 54		
Willamette	1881	....do	335	9	39	1	24	0	2,264						38 and 70 x 54		
San Marcos	1882	... do	317	8	39	5	21	4	2,839						38 and 70 x 54		
Guyandotte	1882	....do	207	0	40	5	24	4	2,140						38 and 74 x 54		
Roanoke	1882	....do	205	0	40	0	26	9	2,140	(a)	(a)		(a)		38 and 74 x 54	(a)	
San Jose	1882	....do	283	0	37	0	21	0	2,010						34 and 62 x 54		
San Juan	1882	....do	283	0	36	4	22	3	2,010						34 and 62 x 54		
San Blas	1882	....do	283	0	37	0	21	0	2,010						34 and 62 x 54		
Tallahassee	1882	....do	280	0	40	7	24	1	2,700						38 and 74 x 54		
Chattahoochee	1882	....do	280	0	40	7	24	1	2,700						38 and 74 x 54		
Nacoochee	1882	....do	280	0	40	7	24	1	2,700						38 and 74 x 54		
Pilgrim	1882	Side-wheel	378	0	50	0	17	6	3,500						110 x 168		
Finance	......	Screw	300	0	38	0	22	0	2,000						36 and 66 x 54		
Advance	......	....do	300	0	38	0	22	0	2,000						36 and 66 x 54		
Reliance	......	....do	300	0	38	0	22	0	2,000						36 and 66 x 54		

a Figures correspond to those of steamers of the same size above.

The success of this yard has been due to qualities on the part of its founder which have characterized the leading ship-builders of America in a marked degree—energy, a fertile mind, and remarkable ingenuity in adapting vessels to the trade in which they were to be employed. A special study would be made of the kinds of cargoes carried by the vessels in a particular coasting route, and an idea would be formed of a ship which would carry more of the given varieties of goods on a lighter draught of water and at a faster rate of speed than the vessels already in the trade. This idea would be worked out in a ship, in which the builder would take perhaps a quarter interest, in order to show his confidence in it. His operations have been in the main successful, and the two establishments have at times been employed to their full capacity. Fifteen hundred men can be employed in the works at New York, and about 3,000 at Chester. It is one feature of the operations of the firm that measures are taken to secure willing work from the men. They are encouraged to be inventive and faithful by a system of rewards and promotion. Furthermore, the *personnel* of the ship-yard is kept at a high grade of character by the constant recruiting of young men of mechanical education who are fresh from school and are given a chance to go into the yard and rise.

The vessels built at Chester include many of note. The City of Peking and the City of Tokio ran for a long time from San Francisco to China, and were large carriers of cargo and small burners of coal. The Para and the Rio de Janeiro were the builder's own venture in the way of a line of steamships to Brazil, in which trade they ran for three years, being then withdrawn and sold to the Pacific Mail Company. All of the coasting steamers have long, sharp, wedge-like bows, good runs, and easy lines, and have been remarkable for their speed, light draught, and cargo-carrying power. The City of Washington, built in 1877, made in 1879 the run from Havana to New York, 1,230 miles, in 75 hours 21 minutes, the fastest ocean time then recorded for a consecutive period of 75 hours. Her average speed was $16\frac{3}{4}$ nautical miles per hour. The steamer Newport, built afterward by this firm, made the same run in 72 hours 15 minutes. Mr. Roach is now building a sailing vessel of about 2,040 tons, besides many steamers.

A yard was established in 1880 at Marcus Hook, Pennsylvania, for the building of vessels, engines, and boilers, under the title of the Pioneer iron works. A foundery, machine-shop, and blacksmith-shop were put up and fitted with machinery, at a total cost of about $75,000, and eight or ten vessels were built in that and the next two years, consisting of tugs, yachts, and small passenger and freight boats; but the concern did not prosper, and has since gone out of existence.

At Wilmington, on the Delaware, besides the two yards devoted to the construction of wooden vessels, there are two large yards engaged in iron- and steel-ship building. The industry was established here at an early date. The city is practically as near to cheap coal and iron as though it were planted upon the Schuylkill, and the same freight rates govern deliveries there from all parts of the country as at Philadelphia; in fact, iron-ship yards can be located advantageously anywhere upon the western bank of the Delaware for a distance of 90 miles so far as cheap materials are concerned. The two yards in Wilmington devoted to this industry are those of The Harlan & Hollingsworth Company and The Pusey & Jones Company. Both concerns build railway cars, but both have extensive ship-building plant, and rank among the four leading establishments in the United States devoted to the industry now under consideration.

The Harlan & Hollingsworth Company began business in 1836 and built the first iron coasting steamer constructed in the United States. In 1843 they turned their attention to the needs of the merchant marine, and after having turned out two small iron vessels began the construction of the steamer Bangor, which was completed and launched in the following spring, and was, as stated, the pioneer of the great fleet of American-built iron steamers that has sprung into existence in the last forty years to take the place of the old-time heavy wooden coasting craft. The success of the Bangor brought Wilmington at once into active competition with New York as well as with the eastern wooden-ship yards in the construction of the large number of iron steamers which the coasting and inland trades began to demand. Wilmington had skilled labor and cheap materials, and a low scale of wages prevailed, because operatives could afford to accept them on account of cheap rents and moderate living expenses. In the early years of the struggle to establish an American iron-ship building industry The Harlan & Hollingsworth Company stood practically alone, for there were then few, if any, concerns in the country sufficiently well equipped to execute contracts regularly for the large class of iron vessels. The success of their yard was due to the fact that each vessel produced was built with as much care in design and construction as though it were being made by an owner for himself, and the behavior of the vessels afterward was, in consequence, a standing advertisement of the good qualities both of iron ships and American work. The yard received many orders, and it has been busily engaged from the first in building iron vessels of every description, its product being the most varied of that of any American establishment. The concern covers 43 acres of ground, on which there are about fifty different shops and buildings. Those employed in ship work are supplied with machinery modern in type and massive in build. The plant includes, among other things, shears for trimming heavy plates, planers, rolls for bending plates to the proper curvature on the sides of the ship, machines for punching rivet holes in frames and plates, hydraulic riveting apparatus, by means of which rivets can be clinched solidly with one thrust by steam-power, frame-heating furnaces, bed-plates for bending the angle-iron frames to the proper outline, steam-hammers, mold-lofts and pattern shops, and the proper apparatus for constructing engines and boilers. On the wharf there is a set of masting shears that can handle a weight of 100 tons, and engines and boilers are lifted almost bodily into the air and deposited gently in their places in the hulls floating alongside. The secret of the success of iron-ship building in America is, in large part, the use of labor-saving machinery of this description. The water-front is 1,350 feet long, and the yard has a large dry-dock. About 3,000 men can be employed by this establishment. As in the case of the other iron-ship yards with large plant, this constitutes a valuable resource of public importance to the United States; and it is safe to say that if the four large yards on the Delaware did not exist the government would be compelled to maintain several establishments of similar magnitude for naval purposes, with their consequent great expense for the repairs necessary to keep them in order.

The Harlan & Hollingsworth Company is now building vessels of steel in response to the demand for the employment of that material. One iron sailing vessel, the bark Iron Age, built at this yard, was finished in 1869, and had the following dimensions: Length, 142 feet; beam, 30 feet; depth, $18\frac{1}{2}$ feet. During the war there were constructed the following vessels for the government: The iron-clad double-turreted monitor Amphitrite, the iron sloop-of-war Ranger, and the iron-clad monitors Patapsco, Saugus, and Napa. Charles Morgan, of New York, was one of the first merchants to understand the advantage of iron hulls in the coasting trade, and up to 1882 this yard had built for his coasting lines no fewer than 31 iron steamers. Propellers of the largest and finest class have been the favorite product of the yard, but orders have also been taken for steam craft of almost every description, and during late years a study has been made of side-wheel bay and river steamboats. The following is a list of the vessels built at this yard:

VESSELS BUILT BY THE HARLAN & HOLLINGSWORTH COMPANY, WILMINGTON, DELAWARE.

Class.	Name.	For whom.	Tonnage.	Kind.	Type.	Year built.	Remarks.
Steam propeller	Bangor	Parties in Maine	450	Iron	Propeller	1844	Twin-screw engines. Burned at sea; repaired and sold to United States government.
Do	Ashland	George W. Aspinwall	300	do	do	1844	Lost during the war.
Do	Ocean	do	300	do	do	1844	Do.
Do	W. Whilden	Anthony Reybold	450	do	do	1845	Altered into a propeller; running between Baltimore and Philadelphia. Engine, 28 inches diameter by 26 inches stroke.
Steam ferry-boat	Delaware	Winnissimmet Ferry Company	270	do	Side wheel	1846	Of Boston, Mass.
Steamship	Willamette	George W. Aspinwall	450	do	Propeller	1849	
Steam ferry-boat	Winnissimmet	Winnissimmet Ferry Company	270	do	do	1850	Of Boston, Mass.
Steamer	Victoria	Island of Trinidad	750	do	do	1850	For Freeman Rawdon.
Steam ferry-boat	Dido	Camden and Philadelphia Ferry Company.	220	do	do	1850	Inclined low-pressure engine, 31 inches diameter by 7 feet stroke.
Hull for dredge		Delaware and Chesapeake Canal Company.	100	do	Propeller	1851	
Steamer	Clayton	Cornelius Vanderbilt	150	do	Stern wheel	1851	For service on Chagres river. High-pressure engine, 9½ inches diameter by 3 feet stroke.
Do	Bulwer	do	150	do	do	1851	For service on Chagres river. High-pressure engine, 9½ inches diameter by 3 feet stroke.
Steamboat	Richard Stockton	Camden and Amboy Railroad Company.	700	do	Side wheel	1851	Running on North river as an excursion boat. Vertical beam-engine, 48 inches diameter by 12 feet stroke.
Do	Wyoming	Philadelphia and Havre de Grace Steamboat Company.	520	do	do	1851	2 low-pressure vertical condensing beam-engines, 29 inches diameter by 8 feet stroke.
	Zephyr	Joint account, Cape Fear River.	150	do		1851	2 inclined engines, 14 inches diameter by 4 feet stroke.
Steamboat	Major Reybold	Reybold Bros	450	do	do	1852	Running on Delaware river. Low-pressure vertical condensing beam-engine, 40 inches diameter by 12 feet stroke.
Steam ferry-boat	Maryland	Philadelphia, Wilmington and Baltimore Railroad Company.	1,150	do	do	1852	Still in use as a transfer steamer in service of New England Transfer Company between Jersey City and Harlem; thoroughly overhauled in 1883. Two horizontal low-pressure condensing engines, 40 inches diameter by 8 feet stroke.
Steamboat	Thomas A. Morgan	Rockhill, Burdon, Cone, and others.	520	do	do	1853	Low-pressure vertical condensing beam-engine, 44 inches diameter by 10 feet stroke.
Steam ferry-boat	Tri-Mountain	Winnissimmet Ferry Company	280	do	do	1853	Low-pressure vertical condensing beam-engine, 36 inches diameter by 8 feet stroke.
Steamboat	Ogden	Accessory Transit Company of Nicaragua.	160	do	Side wheel	1853	2 inclined engines, 16 inches diameter by 5 feet stroke.
Do	Isaac C. Lea	do	160	do	do	1853	Do.
Steam propeller	Thomas Sparks	Philadelphia Steam Propeller Company.	600	do	Propeller	1853	High-pressure engine, 32 inches diameter by 28 inches stroke.
	San Carlos	Accessory Transit Company of Nicaragua.	650	do		1854	Low-pressure engine, 44 inches diameter by 11 feet stroke.
Steam propeller	Richard Willing	Baltimore and Philadelphia Steamboat Company.	450	do	Propeller	1854	High-pressure engine, 28 inches diameter by 26 inches stroke.
Iron barge	Planet	Philadelphia Steam Propeller Company.	390	do		1854	
Steam propeller	Sophia	do	390	do		1854	
		Delaware and Raritan Canal Company.	100	do		1855	
Steam ferry-boat	W. W. Harllee	Wilmington and Raleigh and Wilmington and Manchester Railroad Company.	220	do		1855	Low-pressure engine, 26 inches diameter by 6 feet stroke.
Bell beacon		United States government	40	do		1855	
Do		do	40	do		1855	
Do		do	40	do		1855	
Do		do	40	do		1855	
Do		do	40	do		1855	
Steam propeller	Kahukee	D. Clark, Scotland Neck, N. C.	150	do	Propeller	1855	Engine 24 inches diameter by 20 inches stroke.
Steamboat	Logan	W. Whilldon and others	320	do	Side wheel	1855	
Do	James A. Requa	New Granada Canal and Navigation Company of New York.		do	do	1855	Two high-pressure engines, 24 inches diameter by 8 feet stroke.
Steam ferry-boat	Hunter Woodis	City of Norfolk	750	do	do	1856	
Steamboat	Curlew	Dr. Thomas Warren, Edenton, N. C.	350	do	do	1856	Low-pressure engine, 29 inches diameter by 9 feet stroke.
Do	Swan	John Richardson, Savannah	220	do	do	1856	2 high-pressure engines, 14 inches diameter by 5 feet stroke.
	Amazon	John A. Moore, Augusta	450	do	Stern wheel	1856	2 high-pressure engines, 22 inches diameter by 6 feet stroke.
	Saint Mary's	Claghorn and Cunningham, Augusta.	450	do	Side wheel	1856	2 low-pressure engines, 30 inches diameter by 8 feet stroke.
	General Rusk	Harris, Morgan & Co., New Orleans, La.	750	do	do	1856	Low-pressure engine, 44 inches diameter by 11 feet stroke.

VESSELS BUILT BY THE HARLAN & HOLLINGSWORTH COMPANY, WILMINGTON, DELAWARE—Continued.

Class.	Name.	For whom.	Tonnage.	Kind.	Type.	Year built.	Remarks.
Steamboat	John A. Warner	J. Cone and others	650	Iron	Side wheel	1856	Low-pressure engine, 44 inches diameter by 11 feet stroke.
Do	Antioquia	Everett & Brown, New York	600	do	do	1857	2 high-pressure engines, 24 inches diameter by 8 feet stroke.
Do	Cecile	Fenn, Peck, and others	460	do	do	1857	Low-pressure engine, 38 inches diameter by 10 feet stroke.
Steam propeller	J. S. Shriver	Baltimore and Philadelphia Steamboat Company.	450	do	Steam propeller.	1857	High-pressure engine, 28 inches diameter by 26 inches stroke.
Steamboat	Pilot Boy	Captain Whillden	375	do	Side wheel	1857	Machinery taken from the steamer Napoleon.
Barge	Faith	David Clark, N. C	150	do		1857	
Do	Hope	do	150	do		1857	
Steam propeller	Ellen S. Terry	O. G. Terry, Hartford, Conn	460	do	Propeller	1857	High-pressure engine, 28 inches diameter by 26 inches stroke.
Steamship	Matagorda	C. Vanderbilt	1,250	do	Side wheel	1858	Running in the Gulf of Mexico. Beam engine, 44 inches diameter by 11 feet stroke.
Steamboat	Ariel	Philadelphia, Wilmington and Baltimore Railroad Company.	360	do	do	1858	Engines out of steamer W. Whillden, 28 inches diameter by 26 inches stroke.
Steam tug	Flamenco	Panama Railroad Company	100	do	Propeller	1858	Engine 18 inches diameter by 18 inches stroke.
Bungo		R. A. Joy, S. A	30	do		1858	
Steamship	Arizona	Charles Morgan	1,100	do	Side wheel	1858	Running in the Gulf of Mexico. Beam engine, 44 inches diameter by 11 feet stroke.
Barge	Enterprise	J. H. Anthony	160	do		1858	
Steamboat	Georgianna	G. R. H. Leffler	750	do	Side wheel	1858	Machinery taken from the steamer Gladiator.
Steamship	Champion	C. Vanderbilt	2,000	do	do	1858	Lost at sea; 2 engines, 42 inches diameter by 10 feet stroke.
Steam propeller	Indianola	C. de Goicoarea	450	do	Propeller	1858	Engine 32 inches diameter by 10 feet stroke.
Steam tug	Indio	Fernando J. L. Calvo, Cuba	100	do	do	1859	Engine 26 inches diameter by 24 inches stroke.
Steamship	Benj. Deford	Merchants' and Miners' Transportation Company.	1,500	do	Side wheel	1859	Low-pressure engine, 56 inches diameter by 11 feet stroke. Running now among the West India islands; name afterward changed to the San Jacinto.
Do	S. R. Spaulding	do	1,500	do	do	1859	Lost at sea in a cyclone. Low-pressure engine, 56 inches diameter by 11 feet stroke; name changed afterward to San Salvador.
Do	Austin	Charles Morgan	1,150	do	do	1859	Now in the Gulf of Mexico. Beam engine, 44 inches diameter by 11 feet stroke.
Steam tug	Adriatic	S. & J. M. Flanagan	120	do	Propeller	1860	High-pressure engine, 18 inches diameter by 18 inches stroke.
Do	Champion	do	120	do	do	1860	Do.
Steam propeller	F. W. Brune	New York and Baltimore Transportation Company.	450	do	do	1860	Engine 28 inches diameter by 26 inches stroke.
Do	Fairfield	D. D. Simmons & Bro	190	do	do	1860	Engine 18 inches diameter by 18 inches stroke.
Steamship	W. G. Hewes	Charles Morgan	2,250	do	Side wheel	1860	Now in the Gulf of Mexico.
Steam propeller	Louisiana	S. & J. M. Flanagan	750	do	Propeller	1860	Engine 32 inches diameter by 28 inches stroke.
	Honduras	James Bishop & Co	150	do	Stern wheel	1860	Engine 9 inches diameter by 4 feet stroke.
Lighter		Panama Railroad Company	260	do		1860	
Steamboat	Virginia Dare	Albemarle Steam Packet Company.	400	do	Side wheel	1861	Sold to government and called Delaware. Engine 38 inches diameter by 10 feet stroke.
Steamship	Hatteras	Charles Morgan	1,450	do	do	1861	Now in the Gulf of Mexico. Engine 50 inches diameter by 11 feet stroke. Called St. Mary when built.
Do	Salvador	Panama Railroad Company	1,600	do	Propeller	1861	Burned and wrecked. Engine 48 inches diameter by 54 inches stroke.
Steamboat	Tequendama	United Magdalena Steamboat Company.	250	do		1861	Two engines, 21 inches diameter by 6 feet stroke.
Steam propeller	General Burnside	R. F. Loper	650	do	Propeller	1861	Engine 30 inches diameter by 28 inches stroke.
Do	Martha Stevens	New York and Baltimore Transportation Company.	400	do	do	1861	High-pressure engine, 28 inches diameter by 26 inches stroke.
Steamship	Saint Mary's	Charles Morgan	1,400	do	Side wheel	1862	Now in Gulf of Mexico. Engine 50 inches diameter by 11 feet stroke.
Steam tug	S. F. Du Pont	S. and J. M. Flanagan	160	do	Propeller	1862	Low-pressure engine, 26 inches diameter by 24 inches stroke.
Do	Rescue	Our own account	160	do	do	1861	Sold to United States government. Low-pressure engine, 26 inches diameter by 24 inches stroke.
Steamship	Crescent	Charles Morgan	1,400	do	Side wheel	1862	Now in Gulf of Mexico. Engine 50 inches diameter by 11 feet stroke.
Iron-clad monitor	Patapsco	United States government	1,200	do	Propeller	1862	Two Ericsson engines, 40 inches diameter by 22 inches stroke.
Steamship	Vineland	R. D. Wood & Co	450	do	do	1862	High-pressure engine, 24 inches diameter by 24 inches stroke.
Do	Alliance	J. B. Bloodgood	650	do	do	1862	Engine 34 inches diameter by 34 inches stroke.
Iron-clad monitor	Saugus	United States government	1,500	do	do	1863	Engine 48 inches diameter by 24 inches stroke.
Steamship	Clinton	Charles Morgan	1,450	do	Side wheel	1863	Now in Gulf of Mexico. Engine 50 inches diameter by 11 feet stroke.
Iron-clad monitor	Napa	United States government	850	do	Propeller	1863	Low-pressure engine, 22 inches diameter by 30 inches stroke.
Steamer	Frances No. 1	Charles Morgan	850	do	Side wheel	1863	In the West Indies. Engine 50 inches diameter by 11 feet stroke.
Do	Louise	do	850	do	do	1863	Running on Chesapeake bay. Engine 50 inches diameter by 11 feet stroke.
Lighter		Panama Railroad Company	220	do		1863	

VESSELS BUILT BY THE HARLAN & HOLLINGSWORTH COMPANY, WILMINGTON, DELAWARE—Continued.

Class.	Name.	For whom.	Tonnage.	Kind.	Type.	Year built.	Remarks.
	Vergoechea	United Magdalena Steamboat Company.	300	Iron	Side wheel	1864	Two engines (high-pressure), 21 inches diameter by 6 feet stroke.
Steam propeller	Wilmington	Williams & Guion	750	do	Propeller	1864	Engine 44 inches diameter by 6 feet stroke.
Steamer	Frances No. 2	Charles Morgan	850	do	Side wheel	1864	Engine 50 inches diameter by 11 feet stroke.
Steamship	Morgan	do	1,450	do	do	1865	Gulf of Mexico. Engine 50 inches diameter by 11 feet stroke.
Do	Harris	do	1,450	do	do	1865	Do.
Do	Harlan	do	1,450	do	do	1865	Do.
Steamboat	Lady of the Lake	do	800	do	do	1865	Washington and Norfolk. Engine 50 inches diameter by 11 feet stroke.
Do	Mary	do	850	do	do	1865	Gulf of Mexico. Engine 50 inches diameter by 11 feet stroke.
Steamer	City of Norfolk	do	900	do	do	1866	Do.
Do	City of Lawrence	Norwich and New York Transportation Company.	1,400	do	do	1866	On Long Island sound. Engine 65 inches diameter by 11 feet stroke.
Steamboat	Laura	Charles Morgan	850	do	do	1866	On Long Island sound. Machinery from the steamer Magnolia.
Launch		Panama Railroad Company	220	do		1867	
Do		do	220	do		1867	
Steamship	J. W. Garrett	New York and Baltimore Transportation Company.	450	do	Propeller	1867	
Do	Josephine	Charles Morgan	1,500	do	Side wheel	1867	Lost at sea. Engine 50 inches diameter by 11 feet stroke.
	Sue	Our account	600	do	do	1867	Engine 32 inches diameter by 9 feet stroke.
	Carrie	P. L. Willingham and others	250	do	do	1867	Engine 16 inches diameter by 6 feet stroke.
Barge	Ianthe	New York and Baltimore Transportation Company.	350	do	do	1868	
	Twilight	Captain Crawford and others	420	do	do	1868	Engine 38 inches diameter by 10 feet stroke.
Steamship	Costa Rica	Panama Railroad Company	600	do	Propeller	1868	Running on the Pacific ocean. Engine 48 inches diameter by 66 inches stroke.
Barge		do	220	do		1868	
Do		do	220	do		1868	
Do		do	220	do		1868	
Do		do	220	do		1868	
Do		do	220	do		1868	
Do		do	220	do		1868	
Steam ferry-boat	Southampton	East River Ferry Company	500	do	Side wheel	1868	Engine 48 inches diameter by 10 feet stroke.
	Maggie	Eastern Shore Steamboat Company.	375	do	do	1869	Engine 32 inches diameter by 6 feet stroke.
Bark	Iron Age	Tupper & Beattie	650	do		1869	
Ice-boat		Chesapeake and Delaware Canal Company.	50	do		1856	
Do		do	50	do		1856	
Steam collier	Leopard	Philadelphia and Reading Railroad Company.	609	do	Propeller	1870	Engine 40 inches diameter by 30 inches stroke.
Steamship	Wyanoke	Old Dominion Steamship Company.	2,067	do	Side wheel	1870	New York to Richmond. Engine 70 inches diameter by 11 feet stroke.
Do	Hutchinson	Chas. Morgan	1,435	do	do	1870	Gulf of Mexico. Engine taken from the steamer Mary Roberts.
Do	Whitney	do	1,338	do	do	1871	Gulf of Mexico. Engine 56 inches diameter by 11 inches stroke.
Steam propeller	Roanoke	Baltimore Steam Packet Company.	531	do	Propeller	1871	Chesapeake bay. Engine 34 inches diameter by 34 inches stroke.
Steamship	William Crane	Merchants' and Miners' Transportation Company.	1,418	do	do	1871	Baltimore to Boston. Engine 60 inches diameter by 44 inches stroke.
	Helen	Eastern Shore Steamboat Company.	350	do	Side wheel	1871	Engine 30 inches diameter by 6 feet stroke.
Steam tug	Transfer	Baltimore and Ohio Railroad Company.	101	do	Propeller	1872	Engine 28 inches diameter by 28 inches stroke.
Steamship	Old Dominion	Old Dominion Steamship Company.	2,223	do	Side wheel	1872	New York to Richmond. Engine 75 inches diameter by 11 feet stroke.
Do	Acapulco	Pacific Mail Steamship Company.	3,000	do	Propeller	1872	New York to Aspinwall.
Do	Granada	do	3,000	do	do	1872	San Francisco to China.
Steam ferry-boat	Peerless	Gloucester Ferry Company	200	do	Side wheel	1872	Engine 38 inches diameter by 8 feet stroke.
Steamer	Gussie	Charles Morgan	998	do	do	1872	Gulf of Mexico. Engine from steamship Matagorda.
Launch		Panama Railroad Company	260	do		1873	
Do		do	260	do		1873	
Steamship	General Whitney	Metropolitan Steamship Company.	1,840	do	Propeller	1873	New York to Boston. Engine 36 inches diameter by 60 inches stroke.
Do	Johns Hopkins	Merchants' and Miners' Transportation Company.	1,471	do	do	1873	Baltimore to Boston. Engine 60 inches diameter by 44 inches stroke.
Steam propeller	Westover	Baltimore Steam Packet Company.	577	do	do	1873	Chesapeake bay. Engine 34 inches diameter by 34 inches stroke.
Steam ferry-boat	Pennsylvania	Camden and Philadelphia Steam Ferry Company.	220	do	Side wheel	1873	Engine 38 inches diameter by 9 feet stroke.
	Richmond	Old Dominion Steamship Company.	1,438	do	Propeller	1873	Engine 50 inches diameter by 60 inches stroke.
	Hampton	do	624	do	Side wheel	1874	Engine 38 inches diameter by 9 feet stroke; sold to Mexican waters, and name changed to Tlacotalpan. Now running in Gulf of Mexico.

VESSELS BUILT BY THE HARLAN & HOLLINGSWORTH COMPANY, WILMINGTON, DELAWARE—Continued.

Class.	Name.	For whom.	Tonnage.	Kind.	Type.	Year built.	Remarks.
Steam ferry-boat	City of Chelsea	Winnissimmet Ferry Company	273	Iron	Side wheel	1874	Engine 38 inches diameter by 9 feet stroke.
Steam propeller	Shirly	Baltimore Steam Packet Company.	576	..do	Propeller	1874	Chesapeake bay. Engine 34 inches diameter by 34 inches stroke.
Steam sloop	Ranger	United States government	1,100	..do	....do	1874	In the United States service. Compound engines, 22 and 48½ inches diameter by 42 inches stroke.
Steam propeller	Seaboard	Baltimore Steam Packet Company.	662	..do	....do	1874	Chesapeake bay. Engine 34 inches diameter by 42 inches stroke.
	Chowan	Albemarle Steam Navigation Company.	459	..do	Side wheel	1875	Machinery from the steamboat Ella.
	Tangier	Eastern Shore Steamboat Company.	589	..do	....do	1875	Engine 32 inches diameter by 9 feet stroke.
Steamship	Lone Star	Charles Morgan	2,255	..do	Propeller	1875	New York to New Orleans. Engine 50 inches diameter by 60 inches stroke.
Do	New York	..... do	2,255	..do	....do	1875	Do.
Steam ferry-boat	Dauntless	Gloucester Ferry Company	301	..do	Side wheel	1875	Engine 38 inches diameter by 9 feet stroke.
Do	Delaware	Camden and Philadelphia Steamboat Ferry Company.	371	..do	....do	1875	Machinery from the old steamer Delaware.
Fire-boat	Protector	New Harbor Protection Company.	158	..do	Propeller	1875	Engine 26 inches diameter by 28 inches stroke.
Steamship	Algiers	Charles Morgan	2,270	..do	....do	1876	New York to New Orleans. Engine 50 inches diameter by 60 inches stroke.
Do	Morgan City	......do	2,271	..do	....do	1876	Do.
	Columbia	Delaware River Steamboat Company.	664	..do	Side wheel	1876	Engine 50 inches diameter by 11 feet stroke. Now on the Delaware river.
Steam yacht	Meteor	Carson Lumber Company	20	..do	Propeller	1876	Engine 10 inches diameter by 12 inches stroke. Now running on lake Tahoe, in the Rocky mountains.
Steam ferry-boat	Flushing	East River Ferry Company	581	..do	Side wheel	1876	Engine 44 inches diameter by 9 feet stroke.
Steamboat	Carolina	Baltimore Steam Packet Company.	984	..do	....do	1877	Baltimore to Norfolk. Engine 60 inches diameter by 11 feet stroke.
Do	B. S. Ford	Chester River Steamboat Company.	370	..do	....do	1877	Chesapeake bay. Engine 38 inches diameter by 9 feet stroke.
Steam ferry-boat	Columbia	West Jersey Ferry Company	380	..do	....do	1877	Engine 38 inches diameter by 10 feet stroke.
Steamship	Aransas	Charles Morgan	1,157	..do	Twin propeller.	1877	Gulf of Mexico. Twin screws; engine 30 inches diameter by 36 inches stroke.
Steam ferry-boat	Jas. M. Waterbury	Nassau Ferry Company	413	..do	Side wheel	1877	Engine 38 inches diameter by 9 feet stroke.
Dredge	Hull	American Dredging Company	69	..do		1877	
Steamer	Republic	J. Cone and associates	1,285	..do	....do	1878	Now running on the Delaware river. Engine 66 inches diameter by 12 feet stroke.
Steam tug	Jose Gonzales	Lyles & Gilson	30	..do	Propeller	1878	Engine 14 inches diameter by 14 inches stroke.
	Mary Morgan	Charles Morgan	370	..do	Side wheel	1878	Engine 38 inches diameter by 9 feet stroke.
Steamer	Saint John's	Commercial Navigation Company.	1,098	..do	....do	1878	Engine 66 inches diameter by 12 feet stroke. Ran on the route between Charleston and Jacksonville.
Steam yacht	Victor	J. T. Gause	14	..do	Propeller	1878	Engine 6 inches diameter by 8 inches stroke.
Steamer	Virginia	Baltimore Steam Packet Company.	990	..do	Side wheel	1879	Baltimore to Norfolk. Engine 50 inches diameter by 11 feet stroke.
Steam yacht	Dione	E. A. Harvey	7	..do	Propeller	1879	Engine 18 inches diameter by 10 inches stroke.
Steam ferry-boat	Cooper's Point	Camden and Atlantic Railroad Company.	389	..do	Side wheel	1879	Engine 38 inches diameter by 10 feet stroke.
Do	Rockaway	East River Ferry Company	521	..do	....do	1879	Engine 44 inches diameter by 9 feet stroke.
Do	No name given	Oregon and California Railroad Company.	440	..do	....do	1879	Engine 20 inches diameter by 60 inches stroke.
Steamship	Decatur H. Miller	Merchants' and Miners' Transportation Company.	2,296	..do	Propeller	1879	Baltimore to Boston. Compound engine, 24 and 54 inches diameter by 48 inches stroke.
Steam ferry-boat	Newtown	Nassau Ferry Company	450	..do	Side wheel	1879	Engine 38 inches diameter by 9 feet stroke.
Do	Arctic	West Jersey Ferry Company	394	..do	....do	1879	Engine 40 inches diameter by 10 feet stroke.
Sailing yacht	Mischief	J. R. Busk	111	..do		1879	
Transfer boat	Canton	Philadelphia, Wilmington and Baltimore and Baltimore and Ohio Railroad Companies.	1,178	..do	Side wheel	1880	2 independent engines, 30 inches diameter by 9 feet stroke. Transfer steamer in Baltimore harbor.
Steamer	Albany	A. Vansantvoord	1,380	..do	....do	1880	On Hudson river.
Steam ferry-boat	Long Beach	East River Ferry Company	520	..do	....do	1880	Engine 44 inches diameter by 9 feet stroke.
Steamboat	Excelsior	Potomac Steamboat Company	774	Wood	....do	1880	Engine 40 inches diameter by 9 feet stroke.
Steam yacht	Falcon	Norris Peters	120	Iron	Propeller	1880	Engine 16 inches diameter by 16 inches stroke.
Pilot boat	Pilot	Board of Maryland Pilots	190	..do	....do	1880	Compound engine, 22 and 36 inches diameter by 26 inches stroke.
Steamer	City of Worcester	Norwich and New York Transportation Company.	2,490	..do	Side wheel	1881	New York to New London. Engine 90 inches diameter by 12 feet stroke.
Steamboat	Ida	Maryland Steamboat Company	589	..do	....do	1881	Chesapeake bay. Engine 40 inches diameter by 10 feet stroke.
	Gaston	Baltimore Steam Packet Company.	847	..do	Propeller	1881	Compound engine, 26 and 44 inches diameter by 36 inches stroke.
Steam ferry-boat	Baltic	West Jersey Ferry Company	399	..do	Side wheel	1881	Engine 42 inches diameter by 10 feet stroke.
Do	Wenonah	Camden and Philadelphia Steamboat Ferry Company.	439	..do	....do	1881	Engine 44 inches diameter by 10 feet stroke.
Do	Beverly	......do	439	..do	....do	1881	Do.
Do	Jamaica	Nassau Ferry Company	495	..do	....do	1881	Engine (inclined) 38 inches diameter by 9 feet stroke.
Do	Baltimore	Pennsylvania Railroad Company	730	..do	....do	1882	Engine 46 inches diameter by 11 feet stroke.
Do	Chicago	......do	730	..do	....do	1882	Do.

VESSELS BUILT BY THE HARLAN & HOLLINGSWORTH COMPANY, WILMINGTON, DELAWARE—Continued.

Class.	Name.	For whom.	Tonnage.	Kind.	Type.	Year built.	Remarks.
Steamboat	Avalon	Maryland Steamboat Company	589	Iron	Side wheel	1882	Chesapeake bay. Engine 40 inches diameter by 10 feet stroke.
	Corsica	Chester River Steamboat Company.	368	..do	Propeller	1882	Engine 26 inches diameter by 24 inches stroke.
Steamship	Excelsior	Morgan's Louisiana and Texas Railroad and Steamship Company.	3,264	..do	..do	1882	New York and New Orleans. Compound engine, 36 and 76 inches diameter by 54 inches stroke.
	City of Jacksonville	De Bary Merchants' Line	481	..do	Side wheel	1882	Two inclined engines, 30 inches diameter by 6 feet stroke.
Total tonnage			132,606				

The Pusey & Jones Company has built about 100 iron vessels, 80 of them for foreign owners, chiefly in South America. A few of the above have been built of steel, on foreign account also. The yard has especially studied the requirements of the river trade of South America, and has made a large number of stern-wheel and side-wheel paddle boats.

One of the large vessels of this concern is the Hudson, built in 1874 for the Cromwell line to New Orleans with engines on a new principle. The steamer is a two-decker, with cabins on the upper deck, and is schooner rigged. Her dimensions are: Register, 1,872 tons; length on the load-line to the afterside of the stern-post, 280 feet; beam, molded, 34 feet; depth from upper deck to keel, 26 feet. Her scantling were as follows:

Keel.—Bar-iron, 10 by 2½ inches, scarfed 24 inches.

Stem.—Bar-iron, 10 by 2½ inches.

Stern-posts.—Forward or propeller post, 11 by 5 inches; rudder-post, 10 by 5 inches; bottom part, 7 by 7 inches, the foot extending forward 7 feet, so as to form that much of the keel.

Frames.—Angle-iron, 5 by 3 inches; ½ inch thick for 160 feet amidships; 5 by 3 by $\frac{7}{16}$ inches forward and aft of that; spacing, 24 inches. The frames are double under the engines; the frame runs to the main deck, and the forward cants to the forecastle deck. Reverse angle-irons, 3½ by 3 by $\frac{7}{16}$ inches for 180 feet amidships, then 3½ by 3 by $\frac{6}{16}$, running to the main deck and lower deck on alternate frames.

Floor plates.—Over the keel, 22 inches deep, $\frac{9}{16}$ inch thick for 170 feet amidships; forward and aft, ½ inch thick, and not less than 11 inches deep at the bilge—all carried to the upper part of the bilge. In the ends of the vessel the plates increase in depth, as is usual in all iron vessels, tying the sides together like partial bulkheads.

Beams.—Lower deck: Bulb, T-iron, 9 inches deep, ½ inch thick for 160 feet amidships; fore and aft, 8 inches deep by ½ inch thick. Main deck: Same kind of iron, 8 inches deep by ½ inch thick for 180 feet amidships, and then $\frac{7}{16}$ inch thick. Angle-irons, 3½ by 3 by $\frac{6}{16}$ inch, form the top of the T in both sets of beams. Fifteen orlop beams of double T-iron in the hold, 10 inches deep; top and bottom flanges 5 inches wide, $\frac{9}{16}$ inch thick; forward of the forward bulkhead, angle-irons, 4½ by 4 by $\frac{7}{16}$; forecastle beams, 5 inches deep, $\frac{7}{16}$ thick.

Stanchions.—Lower hold, 3½ inches in diameter; between decks, 3 inches.

Plating.—Garboards: ⅘ inch thick amidships, $\frac{9}{16}$ forward and aft. Bilge and bottom strakes, ⅝ inch, tapering to $\frac{9}{16}$ at the bow and stern; from the bilge to the sheer strake, $\frac{9}{16}$ inch for 175 feet amidships, tapering then to ½ inch. Sheer strake, $\frac{11}{16}$ inch for 180 feet amidships; then for 22 feet, ⅝ inch; then, $\frac{9}{16}$ inch. Forecastle bulwark plates, $\frac{6}{16}$ inch. The sides are double riveted, except in the heavy plates and the butts, which are treble riveted, and in the plates which are not more than $\frac{6}{16}$ thick, where the seams are single riveted.

Keelsons.—Main: intercostal, rising the full depth of the floor plates and 10 inches above them of $\frac{11}{16}$-inch iron, each intercostal plate being secured to the floors by two angle-irons at each end 3½ by 3 by $\frac{7}{16}$ inch. A plate 10 inches wide, ⅝ inch thick, is laid flat on top of the floors each side of the intercostal plates, and is secured to the latter by an angle-iron 5 by 4 by $\frac{9}{16}$ inch. Two angle-irons of the same size, continuous fore and aft, are riveted to the upper edge of the intercostal plates, and on top of them again is a flat plate, 8 inches wide and $\frac{11}{16}$ inch thick. This collection of plates and angles is riveted at every point. Side keelsons are put in half way to the bilge for about 200 feet amidships. They are intercostal, $\frac{9}{16}$ inch thick, rising 5 inches above the floors, secured to the floors by angle-irons at the ends 3½ by 3 by $\frac{7}{16}$ inch, and by a continuous angle-iron fore and aft, each side on top of the floors 5 by 4 by $\frac{9}{16}$ inch. The bilge keelsons at the upper and lower turn of the bilge are composed of two angle-irons, each 5 by 4 by $\frac{7}{16}$ inch, riveted back to back.

Stringers.—On the ends of the deck beams, all three tiers, around the ship. Lower deck, 30 inches wide and $\frac{9}{16}$ inch thick for 140 feet, tapering to 20 by ½ inch at ends. Main deck, 46 by $\frac{9}{16}$ inch amidships, tapering to 26 by ½ inch at the ends, riveted to the shell by pieces of angle-iron and to frames by a continuous angle-iron 5 by 4 by $\frac{9}{16}$ inch thick. On hold beams, 8 by ¾ inch, with angle-irons on top of and below the beam ends 4½ by 4 by $\frac{9}{16}$ inch.

Tie plates.—Fore and aft on the beams, on each side of the hatches, on lower deck, 12 by ½ inch; on main deck, 18 by ½ inch.

Bulkheads.—Four transverse, ⅜ inch thick, stiffened with angle-irons 5 by 3 by ½ inch, spaced 2 feet apart. The bulkheads run to the main deck, and are water tight. There are bulkheads on each side of the engine and boiler rooms, forming, with the sides of the ship, bunkers for coal. Shaft tunnel of ⅜-inch iron.

Rudder.—Wrought iron, 7½ inches in diameter at the head, the frame all forged, and plated with ⅜-inch iron.

Bulwarks.—Height, 3¾ feet; light iron, with white oak rail, 7½ by 2½ inches.

Wood work.—Ceiling of the floor of the hold, 2½-inch pitch-pine; sides of the hold, 2-inch pine; decking, 4-inch yellow pine; foremast, 72 feet in height above the main deck, white pine, 22 inches in diameter; mainmast, 80 feet by 21 inches.

Boilers.—Four in number, return tubular, 9 feet in diameter, 14 feet long, of ½-inch iron, with 140 tubes, 3½ inches each; safety-valves set at 77 pounds; allowed to carry 75 pounds of steam; working pressure, 65 pounds.

Engines.—Vertical; surface-condensing poppet-valve. Cylinder, 48 inches in diameter, 6-foot stroke; steam cut-off at 7 inches from beginning of the stroke; revolutions, 65 per minute.

Wheel.—Screw; 15 feet in diameter; 22 feet pitch; gun-metal blades.

Class.—A 1 for 20 years.

The engines of the majority of propellers are of the compound surface-condensing type, in which steam is expanded at a low pressure. In the Hudson, however, the working pressure is 65 pounds. The ship has been driven at an average of 12½ knots on a consumption of 20 tons of coal per day, and her speed often averages 14 knots for the whole trip to New Orleans.

At Baltimore there was some iron-ship building before the war, in a fragmentary way, however. One of the vessels launched by Ross and Thomas Winans in 1858, designed to be a new type of express steamer and to carry only passengers and a small quantity of valuable freight, was 180 feet long, with 16 feet beam, without keel or cutwater, but was provided with four high-pressure engines. The hull was arched on deck in such way that no sea that came aboard could be retained, and the boat was large enough to accommodate about 20 passengers, the mails, and a limited amount of express matter. Baltimore is favorably situated for the construction of iron vessels. The war interrupted the growth of the business, but another beginning was made in 1872 by the construction of two composite vessels for the government by William E. Woodall & Co., the small sailing vessels Speedwell and Bibb. The following year the little schooners Palinurus and Research, each of 76 tons, were built by the the same firm, and in 1876 the Earnest of 80 tons, the Ready of 80 tons, and the Drift of 87 tons, all schooners, and, like the others, all for the coast survey. The timbers and deck frames of these boats were of angle-iron, all the rest oak and pine. Woodall & Co. also designed the composite single-deck propeller Thomas G. Gedney, of 133 tons, for the coast survey, which was built by Delamater, of New York, in 1875. This vessel was 130 feet long on deck, $24\frac{1}{2}$ feet beam, molded, and 8 feet deep in the hold. The stem, apron, knight-heads, keel, stern-post, and deadwood were of oak and locust, and the planking yellow pine, 6 inches thick on the garboards, $4\frac{1}{2}$ on the wales, and 3 on the bulwarks. Yellow pine, 12 by 5 inches, was used for the plank-sheer and rail, and white pine, $3\frac{3}{4}$ inches square, for the decking. The frames were of angle-iron, 3 by $2\frac{1}{2}$ by $\frac{3}{8}$ inches, spaced 18 inches; the reverse angles $2\frac{1}{4}$ by $2\frac{1}{4}$ by $\frac{5}{16}$, extended on alternate frames to 6 inches above the bilge keelson and to the deck. The floor plates were 12 inches deep over the keel, $\frac{3}{8}$ inch thick, and diminished to a molding of 3 inches on the bilge. Although the vessel had a wooden keel 10 inches square, an iron keel plate was laid on top of it 18 inches wide and $\frac{3}{8}$ inch thick, which ran clear fore and aft and lapped on the stem and the stern-post. The keelson was intercostal, of $\frac{3}{8}$-inch iron, with flat plates on each side of it, same thickness and 18 inches wide, and with an angle-iron on each side, uniting the vertical to the flat plates, $2\frac{1}{4}$ by $2\frac{1}{4}$ by $\frac{5}{16}$ inches. A double angle-iron side keelson each side was composed of 5 by 3 by $\frac{7}{16}$-inch iron. Bilge keelsons, double, of angle-iron, 3 inches by $3\frac{1}{2}$ by $\frac{3}{8}$. The deck beams were 5 inch bulb T-iron. One narrow strip of $\frac{3}{8}$-inch plating about 9 inches wide was riveted to the frames just below the floor head, and another 18 inches wide was riveted on the timbers as a sheer streak. There were 3 bulkheads of $\frac{1}{4}$-inch iron. The planking was put on with screw bolts, the heads countersunk, cemented, and plugged with wood, and five streaks on the bilge were edge-bolted amidships for 90 feet with $\frac{5}{8}$-inch iron. This vessel was coppered over the planking. The hull thus made was light and strong, and the vessel did good service.

In 1876 a regular iron-ship yard was established in Baltimore on the point near the fort by the firm of Malster & Reaney. Shops were put up for the various operations of the ship-yard, including boiler and blacksmith, machine, joiner, and boat shops; also a foundery and mold-loft, with a wareroom 500 feet long, and office and store-room. A large basin dry-dock was also made on the grounds 450 feet long and 113 feet wide on top, measured inside the basin gates. A fair equipment of machinery was purchased, including a steam riveter. The work of the yard has been chiefly boiler building and repair work, but vessels have been built from time to time, and the business appears to be on a substantial foundation. The following was the production up to the census year:

Description.	Name.	Kind of wheel.	When built.	Length between perpendiculars.	Beam molded.	Depth of hold.
				Ft. In.	Ft. In.	Ft. In.
Tug	Alexander Jones	Screw	1876–'77	97 0	22 0	10 $0\frac{1}{2}$
Do	Camilla	do	1877–'78	62 0	16 0	7 0
Ice-boat	F. C. Latrobe	Side wheel	1877–'78	200 0	34 0	14 0
Yacht	Chronometer	Screw	1877–'78	42 6	6 9	4 10
Steamer	Enoch Pratt	Side wheel	1878	155 0	29 0	8 6
Tug	Canton	Screw	1879	70 0	16 6	7 9
Ferry-boat	Robert Garrett	Side wheel	1880–'81	125 0	25 0	11 0
United States light-house tender	Holly	do	1880–'81	146 3	23 8	9 6
Do	Jessamine	do	1880–'81	146 3	23 8	9 6

A beginning has been made in iron-ship building in San Francisco in spite of the high cost of iron and of labor in that city. The first appears to have been repair work on two large Pacific mail steamers, the City of Peking and the City of Tokio, by men sent out from the East; but in 1879 the iron propeller Bolivar, 13 years old, was taken out of water and enlarged by the Risdon iron works and the Dickie Brothers, wooden-ship builders. She was built in Hull, England, and sold here for $20,000. Registering 1,083 tons, she was cut in two, lengthened 68 feet, and enlarged to 1,462 tons register at an expense of $120,000.

The port of San Francisco is visited yearly by two or three hundred iron sailing vessels from England, and whenever an accident happens to any of them, impairing their seaworthiness, they must have their repairs made there. The Risdon iron works have had several large pieces of work to do on ships driven ashore and damaged. In the bottom of one 33 plates were put, in another almost an entire new bottom was necessary, and there have been a number of similar jobs. In 1879 the ship Jessie Osborne, of Dumbarton, Scotland, of 1,079 tons, only two years old, was wrecked a few miles north of the city, and had a large hole knocked through her hull. She was bought by San Francisco shipping men, raised by tightening the decks and forcing air into the hull under great pressure, towed into port, and there repaired, and when finished cost the new owner about $60,000. Another job of work was on an English iron ship, oil laden, which took fire off the coast of South America. She was towed to the Sandwich islands and then to San Francisco, when the beams which were warped by the heat were either straightened or replaced and the whole ship was repaired and made as good as new.

In the course of these operations the Risdon works and the Dickie Brothers have acquired a considerable acquaintance with iron vessels, and have lately built two small propellers, one for a local water boat, the other of 30 tons for owners in Ecuador. The water boat was finished in the winter of 1881–'82, and is 65 feet long, 13 feet beam, and 7 feet deep, modeled like a tug, weighing about 25 tons with everything aboard except water. The tank holds 10,000 gallons. She has two high-pressure engines, with 8 by 8 inch cylinders, and two boilers 6 by 6 feet, and with a pressure of 100 pounds of steam develops 35 horse-power. The plating is $\frac{1}{4}$ and $\frac{5}{16}$ inch thick; the deck is of corded iron plates $\frac{5}{16}$ inch thick. The rivets of the shell were driven cold.

While the skill has been acquired necessary for iron-ship building, the future of the industry in California is in doubt. Timber is too cheap to encourage a demand for iron sailing ships, and propellers can be built in the East at much lower prices than in San Francisco; but it is of great value to the maritime community to have on the Pacific coast the present means of repairing disabled iron vessels.

Iron boats were first introduced on a river in the South about 1830, the pioneer iron boat of the United States, the Codorus, having been sent to that part of the country about that year. Information in regard to the matter is not very definite, but it is known that the Savannah river had a number of iron boats at an early period. Five were running in 1835. They had all the experiences to which river boats are subject. One of them, built in 1834, was hauled out in 1843 for examination; her bottom had not been perceptibly worn in nine years' service, and there was no trace of her repeated encounters with snags, except an indentation here and there in the hull.

Iron boats were first introduced in the West in 1839. The experiments in Georgia had shown their desirability for service on shallow rivers. Light draught is a *sine qua non* in boats navigating streams where the water dwindles in dry months to 5 feet draught and less, and toughness and strength of hull are important where snags and sunken logs abound in the river bed. The experience of early navigators in the West taught them the value of strong, light, safe boats, and led them to a few attempts at the production of something better than wooden hulls. As before stated, the beginning was in the year 1839, at Pittsburgh; and although comparatively few boats have been built, yet the experience of late years has fully confirmed the lessons of the earlier time. Light hulls are just as desirable as ever; indeed, they become more desirable, now that trade has reached such large proportions and steamers must carry from 2,000 to 3,000 tons of cargo, instead of 400 and 500 tons, as in 1839; and strength and durability also continue to be qualities of the highest importance. About one-half the losses in the West are due to the snagging of wooden boats, their hulls being necessarily of such flimsy construction that the first strong thrust from a sunken tree sends them to the bottom of the river. Vessels that survive the danger of snags and the peril of fire perish, in any event, from natural decay alone in six or seven years. Ocean vessels, with their heavy frames and planking, live for fifteen and twenty years, often longer. In the West the whole tonnage of the rivers must be renewed every six or seven years. In a fleet so perishable the cost of maintenance is excessive. Natural depreciation goes on at the rate of 16 per cent. a year; insurance ranges from 8 to 12 per cent.; interest is not less than 6 per cent., and annual cost of painting and repair amounts to as much more. The cost of maintenance of tonnage in the West is therefore from 30 to 35 per cent., or twice that of the ocean fleet. Steamboat men, therefore, thoroughly understand the value of a safer and more durable class of tonnage than that which they now own, and nothing except the cost of iron boats has stood in the way of their universal adoption.

The pioneer iron boat at Pittsburgh was the Valley Forge, which was built at the iron works of Robinson, Minnis & Miller, on the south side of the Monongahela, a short distance above the bridge. She was 165 feet long, 25 feet beam, and $5\frac{1}{2}$ feet deep, and was a side-wheeler. This first experiment was regarded as the inauguration of a new and great industry. In 1841 the boat was lengthened 15 feet, making her 180 feet long, and over the paddle-wheel guards she was 50 feet wide. She was then as large as the locks at Louisville would admit. A cabin covered her whole deck, with accommodations for 200 passengers. The frames were of angle-iron, the beams of T-iron. The plating of the hull was $\frac{1}{4}$ inch thick, and the lower deck was laid with $\frac{3}{16}$-inch iron plates. Her keel was of flat plate iron, 12 inches wide, dished. The cylinder timbers and frames of the wheels were also of iron. Owing to the lightness of the hull she could carry 400 tons on about $4\frac{1}{2}$ feet draught. The Valley Forge cost, however, twice the amount for which a wooden steamer of the same size could have been built. She ran successfully on the Ohio, Cumberland, Tennessee, and Mississippi rivers until 1845, a part of the time as a packet between Nashville and New Orleans, and was sunk once in the Mississippi, but was raised, and did good service thereafter. In 1845 she was dismantled and broken up. Trade had increased in the West, and boats of twice her size were being built and run at small additional expense. Her machinery was transferred to another vessel, and the iron of the hull was sold to the government for $2\frac{1}{2}$ cents per pound and sent to Harper's Ferry, where most of it was used in the manufacture of musket barrels. Experience with this vessel taught the need of thicker plates on the bottom of the hull, and also threw some doubt for a time on the utility of iron boats on the upper Ohio, where the bed of the river is generally composed of rock and gravel and the stage of water is so scant that boats rub on the bars. Some of her bottom plates had been worn down to $\frac{1}{16}$ inch in thickness. In 1845 the iron revenue-cutter George M. Bibb was built at the Fort Pitt works, on the Allegheny, at Pittsburgh, and was dispatched to the Gulf of Mexico. She was at first propelled by a screw, but the wheel did not work well, and it was taken out at Cincinnati and side paddle-wheels substituted. She was then sent on to the Gulf. Soon after two other iron revenue-cutters were built at Pittsburgh, the Lake Erie and the Lake Michigan, which were sent through to the lakes via the Lake Erie canal.

In 1847 the Allegheny was built at Pittsburgh, also for the government, and was a larger boat than her predecessors. Her dimensions were: Length on deck, 185 feet; on the keel, 171 feet; beam on deck, $33\frac{1}{3}$ feet; beam at the wheels, 25 feet; depth of hold, 19 feet; mean draught, $13\frac{1}{2}$ feet; register, 1,200 tons. The total weight of the hull was 425 net tons; her total displacement, 1,050 tons. The machinery, with coal-bunkers and chimney, weighed 573,000 pounds. Her engines cost \$61,000; the whole boat \$292,000. Captain Hunter, of the United States navy, under whose direction the Allegheny was built, supplied her with two wheels amidships $14\frac{2}{3}$ feet in diameter, with paddles $3\frac{1}{2}$ feet wide and $2\frac{1}{6}$ feet long, the intention being to place them where they would be protected from cannon shot; but in service these wheels failed to give satisfaction, and were taken out and the boat provided with common paddle-wheels. An extended cruise was taken by the Allegheny, and from New Orleans she went to Norfolk, and thence to the Mediterranean. It was at first thought that she would answer for a war steamer, but she proved too light for the purpose, and was strengthened afterward by putting in new frames between the old ones. The Hunter, 100 feet long, was also built at Pittsburgh on the same principle as the last-named boat.

This was a good beginning in iron steamboat building in the West, but the high cost of the vessels deterred transportation companies from ordering the new class of tonnage. During the war several other government vessels were constructed at the iron works in Pittsburgh, among others the monitors Manayunk and Umpqua and the light-draught gunboats Sandusky and Marietta. The war having come to an end before any of these vessels were finished, they did not reach the lower waters, but with the exception of the Manayunk were detained at Cairo and sold. The hulls were broken up and a great deal of the iron found its way back to Pittsburgh, to be worked over into new forms. Since the war about 15 other iron boats, mostly of small size, have been built, all for private owners, a number of them tugs. Three light-draught boats were made by Hartupee & Co. on South American orders. They were sent to New York and shipped thence to their destination, and were, respectively, 135 feet long, 26 feet beam, $4\frac{1}{2}$ feet hold, 85 feet long, 15 feet beam, and 3 feet hold, and 50 feet long, 12 feet beam, and $2\frac{1}{2}$ feet hold. None of the seven or eight concerns which built iron boats at Pittsburgh had regular ship-yards, but they were all proprietors of iron works. The largest vessel of the period since the war is the steel dredge boat made by G. W. R. Bayley for use at the mouth of the Mississippi, 200 feet long, $32\frac{7}{12}$ feet broad, and 10 feet hold, with 28-foot paddle-wheels, and engines 21 inches in diameter by 7 feet stroke. The Bayley was admirably adapted to the purposes for which she was built, being light, strong, and serviceable.

At Pittsburgh coal is abundant and cheap. The whole region is full of excellent iron, and there has been no lack of fine engineering talent or of workmen of the highest skill. But in spite of all these advantages and the conceded utility of iron boats there has been one obstacle to overcome which the iron men have found insuperable. Oak has been as abundant as iron, and far cheaper. From the beginning down to the present day the wooden hull has cost only about one-half the expense of an iron hull, and it has been in vain to compete for orders from steamboat owners. At present there is only one yard building iron vessels in Pittsburgh, the property of James Rees & Sons, which is employed chiefly on foreign orders. The specialty of this firm was originally the construction of steamboat engines, but in 1878 they went into vessel building, the firm being then known as Rees & Thorn. The yard is on the Allegheny side of the city. Down to 1882 the following vessels had been built:

1878. Stern-wheel steamboat Francisco Montayer, 150 feet long, 28 feet beam, 4 feet hold, for South America.
1879. Stern-wheel steamboat Victoria, 155 feet long, $32\frac{1}{2}$ feet beam, 5 feet hold, for South America.
1879. Stern-wheel steamboat Venezuela, 120 feet long, 24 feet beam, 3 feet hold, for South America.
1879. United States medical boat Benner, 118 feet long, 19 feet beam, $3\frac{1}{2}$ feet hold.
1879. Steam catamaran for Saratoga lake, New York, each hull 146 feet long, 14 feet beam, 5 feet hold; the hulls of steel.
1880. Three small tugs for the government, 37 feet long, $7\frac{1}{2}$ feet beam, $3\frac{1}{2}$ feet hold; hull of steel.
1881. Stern-wheeler Roberto Carlistor, 112 feet long, 22 feet beam, 3 feet hold, for South America.
1881. Stern-wheeler De Castro, 112 feet long, 22 feet beam, 3 feet hold, for South America.
1881. Stern-wheeler Chattahoochee, 155 feet long, $31\frac{1}{2}$ feet beam, 5 feet hold, for the Chattahoochee river, Alabama.

The Chattahoochee was building in the census year, and was of Siemens-Anderson steel throughout, very light and strong. She was perfectly flat on the bottom, the bilge quick, and the sides flaring 6 inches, as in other river steamers. The frames were 2 by 2 inches by $\frac{1}{4}$ inch, and every other one carried a reverse angle-iron; spacing 14 inches. The hull was provided with five transverse bulkheads and three running fore and aft, the latter being principally depended upon for strength, especially when in contact with snags. Plating, $\frac{1}{4}$, $\frac{3}{16}$, and $\frac{1}{8}$ inch steel, fastened with double rows of $\frac{3}{8}$ and $\frac{5}{8}$ inch rivets, driven cold. The deck frame was of steel, but planked with pine. The Chattahoochee was built for the cotton trade of the Chattahoochee river, and was expected to carry nearly 400 tons of freight.

Only a few iron boats have been built at Cincinnati. One was an excursion steamer, for use in the vicinity of New Orleans, 130 feet long, 36 feet beam, and 4 feet hold; but she was too shallow for the waters navigated, and by mismanagement was sunk in deep water. Another boat of larger size, built about ten years ago, is running yet. She is 200 feet long, and draws only 30 inches of water, light. The lack of demand for such expensive craft prevents the development of the industry in Cincinnati.

The work done at Dubuque has been of a fragmentary character, and nothing is doing now.

At Saint Louis, in the Carondelet suburbs, there is one large yard owned by the Western Iron Boat Building Company. It was established in 1874 by Charles P. Chouteau, one of a firm owning a large rolling-mill in that locality, under the superintendency of Theodore Allen, of New York, who, with a partner, A. H. Blaisdell, is the present owner.

This yard had produced the following boats down to the year 1882:

1874. Snag-boat O. G. Wagner, for the United States government.

1875. Stern-wheel tow-boat A. Humphries, 125 feet long, 24 feet beam, and 6 feet hold.

1876. Stern-wheel tow-boat W. J. Florence, 120 feet long, 20 feet beam, and 5 feet hold.

1877. Stern-wheel tow-boat Bessie, 120 feet long, 20 feet beam, and 4½ feet hold, for rafting.

1877. Stern-wheel freight-boat Charles P. Chouteau, of 1,304 tons (being the monitor Winnebago altered and lengthened 72 feet), 296 feet long, 54 feet beam, and 8 feet hold. This steamer carried 8,866 bales of cotton and 15,000 sacks of cottonseed into New Orleans on one trip in 1880.

1877. Twin-screw propeller Indianola, United States mail dispatch boat, 90 feet long, 15 feet beam, and 6 feet hold.

1878. Side-wheel United States survey-boats Iris, Doris, Clytie, and Thetis, each 54 feet long, 10 feet beam, and 4½ feet hold. The bows of these boats were peculiar, the stem being inclined backward; a style which did not prove desirable, and which was afterward altered.

1879. Side-wheel United States launch Hebe, 78 feet long over all, 75 feet on the water-line, 15 feet beam, 27 feet over all, 4 feet hold; two engines, 12 inches in diameter, 2 feet stroke; wheels 12 feet in diameter and 5 feet across.

1879. United States snag-boat Horatio G. Wright, side-wheeler, 187 feet long, 62 feet beam, 90 feet over all, 8 feet hold; weight of iron in the hull, 534 tons; total weight of boat, 885 tons; cost, $130,000.

1879. Propeller barge Electra, 66 feet long, 11 feet beam, 4½ feet hold; a tender to the snag-boat.

1879. Two side-wheel United States survey-boats, 82 feet long, 13 feet beam, and 4½ feet hold.

1879. Two stern-wheel United States snag-boats, John R. Meigs and Chauncey B. Reese, 170 feet long, 36 feet beam, and 6 feet hold.

1880. Stern-wheel freight-boat No. 19, 130 feet long, 26 feet beam, and 7½ feet hold.

1880. Screw-tug Susie Hazard, for Saint Louis owners, 95 feet long, 19 feet beam, 9 feet hold; draught of water, 8 feet.

1880. Stern-wheel snag-boat C. W. Howell, 145 feet long, 36 feet beam, and 6 feet hold.

1881. Side-wheel transfer steamer, for the Texas Pacific railroad, being the monitor Chickasaw altered; under construction.

1881. Two tow-boats for the Mississippi River Improvement Commission, under construction, 175 feet long, 32 feet beam, and 6 feet hold.

This company introduces into its new boats the longitudinal system of framing, and it would do the same if it were to construct model barges of iron. Up to the present time no orders have been received for model barges, as the cost of vessels of the new 225-foot size would not be less than $25,000, exclusive of the house on deck, which is more than twice the contract price of wooden barges complete. It is estimated that an iron boat would last from 30 to 40 years, and thus outlive five of the other kind, besides being 15 per cent. lighter, and not grow heavier with age, as do wooden boats. Nevertheless, excess of first cost proves a serious drawback to their introduction. It will illustrate the character of the new Saint Louis steamers to describe the scantling of the tow-boat built in 1881. The data are as follows:

Model.—175 feet long, 32 feet beam, 6 feet depth of hold; the bottom perfectly flat; bilge turned in the square body with 12 inches radius; bow modeled for 75 feet, with entrance long and fine for a western boat. Sheer forward, 5 feet; aft, 2 feet.

Frames.—Longitudinal, 3 feet apart, 2 by 2 inches, with a vertical floor plate 6 inches high, $\frac{5}{16}$ inch thick, with a 2-inch angle-iron along the upper edge. These floor frames draw together in the bow, and when 18 inches apart the outer ones stop short. Between the longitudinal frame irons 2- by 2-inch transverse irons are worked intercostally 3 feet apart. Every other transverse floor frame carries a vertical plate 8 inches high, $\frac{3}{16}$ inch thick, with a continuous angle-iron from bilge to bilge 2 by 2 by $\frac{5}{16}$ inches. The bow is framed on the transverse system with 2½-inch angle-iron. Side frames of the square body, 18 inches apart, 2 by 2 by $\frac{5}{16}$-inch angle-iron, running from the gunwale to the first longitudinal frame on the floor of the boat; every other side frame carries an 8-inch plate, with an angle-iron along the outer edge of it. The transverse floor plates deepen as the bow grows finer, the foremost one being 3 feet in depth.

Bulkheads.—Two longitudinal, 12 feet apart, running from away aft to about 30 feet from the bow, where they are 6 feet apart and end on a transverse bulkhead. They are of $\frac{3}{16}$-inch iron, secured to the skin with 2½ by 2½ by $\frac{5}{16}$ angle-irons; at top, two 2 by ⅜ angle-irons. Four transverse bulkheads, of $\frac{3}{16}$-inch iron, worked between the sides of the vessel and the other bulkheads, and made water-tight.

Stem.—A plate, with cheek pieces for the apron, and broad enough to land the outside plating on and hold it securely.

Keelson.—Depth 18 inches, of ⅜-inch plate, secured below to the skin with a 2 by 2½ by $\frac{5}{16}$ angle-iron on each side of the plate, stiffened with two similar irons at the upper edge. The keelson deepens to 36 inches at the stern of the boat.

Stern.—Framed transversely, and raking so as to allow the use of balance rudder; a floor plate on each frame. Fan-tail of $\frac{3}{16}$-inch plate iron.

Beams.—Spaced 18 inches, of 2½ by 2½ by $\frac{5}{16}$ angle-iron. Every other beam has gusset knees of $\frac{3}{16}$ iron, connecting it with the side frames and fore-and-aft bulkheads. In the center line of the boat and parallel to it, 8 feet each way, 3 by 3 by ⅜ angle-irons are fastened to the under side of the beams with clips, with stanchions of 2½ angle-iron on each plate floor, except that on the main keelson they are of 2½-inch iron. There is a 12-inch girder on the keelson stanchions.

Stringers.—Three on the top timbers on each side of 2½ by 2½ by $\frac{5}{16}$ angle-iron, fastened to clips. They are continued to the stem with a 6-inch plate of ¼ iron, and when the inboard edges of the plate approach to within 2 feet the plate is made in one piece across the boat to form a breast-hook. Stringer plate on the beams 24 inches wide, $\frac{3}{8}$ inch thick, with butt straps treble riveted. Gunwale stringer plate 20 inches wide, with 8 inches worked outboard, $\frac{3}{8}$-inch iron. An angle-iron is riveted on this plate 2 inches from the inside edge to abut the planking of the deck against.

Outside plating.—All $\frac{3}{8}$, $\frac{5}{16}$, and $\frac{1}{4}$ inch thick, rivets $\frac{3}{8}$ inch, 4 diameters apart.

Guards.—Four feet wide amidships, broad at the bow, sustained by outriggers of $2\frac{1}{2}$-inch angle-iron 2 feet apart, turned down 8 inches on the plating and riveted. Over plank-sheer, 12 inches wide, $\frac{5}{8}$ inch thick; under plank-sheer, 12 inches wide, $\frac{1}{4}$ inch thick. Facing, 8-inch channel iron.

Rudders.—Three in number, one a balance rudder. The wing rudders hang on skegs of $\frac{3}{16}$ iron plate made independently and riveted on with angle-iron.

Cylinder timbers.—Iron, 46 inches deep at the transom.

Machinery.—Three steel boilers, made of $\frac{25}{100}$-inch plates; diameter, 42 inches; length, 28 feet, with five 10-inch flues. Two engines, 20 inches in diameter, 6 feet stroke.

Houses.—As usual on tow-boats.

Weight of iron.—Gross weight of iron purchased for hull, 394,640 pounds; waste about 6 per cent., leaving net weight of iron in hull 370,960 pounds.

It is the belief of those in the West most competent to judge that iron or steel is destined finally to take the place of wood in all the larger vessels used for transportation on the rivers. The experience already had on the deeper rivers proves conclusively the durability of iron boats and the small cost of their repairs. Bottom plates on recent boats after eight years' service have shown a reduction of only 2 per cent. in weight, and the framing and interior work have shown no perceptible deterioration. The business of the rivers is at present largely in the hands of persons with limited capital, who cannot afford the expense of iron or steel hulls, and there has therefore been no competition between rival lines of wooden and iron vessels to elicit information as to the commercial superiority of the latter. It is, however, well known that the river traffic of the West would be greatly promoted if freight rates could be lowered; but they cannot be materially lowered at present, owing to the high cost of maintenance and replacement of wooden tonnage. It is the opinion of many in the West that this state of affairs will continue to interest the more observing and intelligent men engaged in transportation until they realize that freight can be carried profitably at lower rates by employing more efficient and more durable hulls, and they will then build boats of either iron or steel, or with iron frames and wooden planking.

On the northern lakes iron ships are of recent introduction, but the new idea is making rapid progress. Since the war the trade of the lakes has grown to large proportions, the cargoes moved by the best paying class of lake vessels being not less than 1,500 tons in dead weight, and often ranging as high as 2,500 tons and more. The peculiarities of the channel between lakes Huron and Saint Clair and of the harbors of the principal cities, and the expectation that laden vessels will before long run direct from Chicago to Montreal through the Canadian canals and perhaps on to Europe, govern the forms of ships. The lake model is, and necessarily must be, long rather than narrow, and limited to about 14 feet draught. In order to give wooden vessels of this model proper strength the hulls must be built with heavy scantling, a great deal of extra fastening and strapping, and with a quantity of timber in the keelsons not seen in any other class of vessels. Wooden hulls are heavy, and there is need on that account alone of the lighter hulls of iron, even if no other considerations came into play. It will be remembered also that the machinery in lake steamers is placed far aft, and that the tendency of its vibration is to rack and strain the hull. Besides, the timber of the lakes is disappearing, and the cost of wooden ships is rising. These are all cogent reasons for building iron ships.

The rise of iron works and boiler and engine shops and the existence of large wooden-ship yards in Buffalo made that city the natural center for first attempting the construction of iron boats on the lakes. The proprietors of large shops turned their attention to iron hulls more than twenty years ago, and from time to time built tugs, yachts, and freight boats of small size until a familiarity with the principles of construction had been obtained. About 1870 an interest in iron propellers was awakened, and the Anchor line contracted for four new vessels of large size to go into their trade to the upper lakes. These propellers were completed in Buffalo in 1871. At various times from 1870 to 1873 there were also built in Buffalo for the various transportation companies five others, all by Gibson & Craig, as subcontractors under the King iron works. They were as follows:

Year.	Name.	Length.	Beam.	Hold.	Tonnage.
		Feet.	*Feet.*	*Feet.*	
1871	India	210	$32\frac{1}{2}$	14	1,239
	China	210	$32\frac{1}{2}$	14	1,239
	Japan	210	$32\frac{1}{2}$	14	1,239
	Alaska	$212\frac{1}{3}$	32	$13\frac{3}{4}$	1,288
1872	Cuba	$231\frac{2}{3}$	$35\frac{2}{3}$	$13\frac{5}{12}$	1,526
	Russia	$231\frac{2}{3}$	$35\frac{2}{3}$	$13\frac{5}{12}$	1,502
	Java (since lost)	$231\frac{2}{3}$	$35\frac{2}{3}$	$13\frac{5}{12}$	1,502
1873	Scotia	$231\frac{2}{3}$	$35\frac{2}{3}$	$13\frac{5}{12}$	1,502
	Arabia	224	34	15	1,203

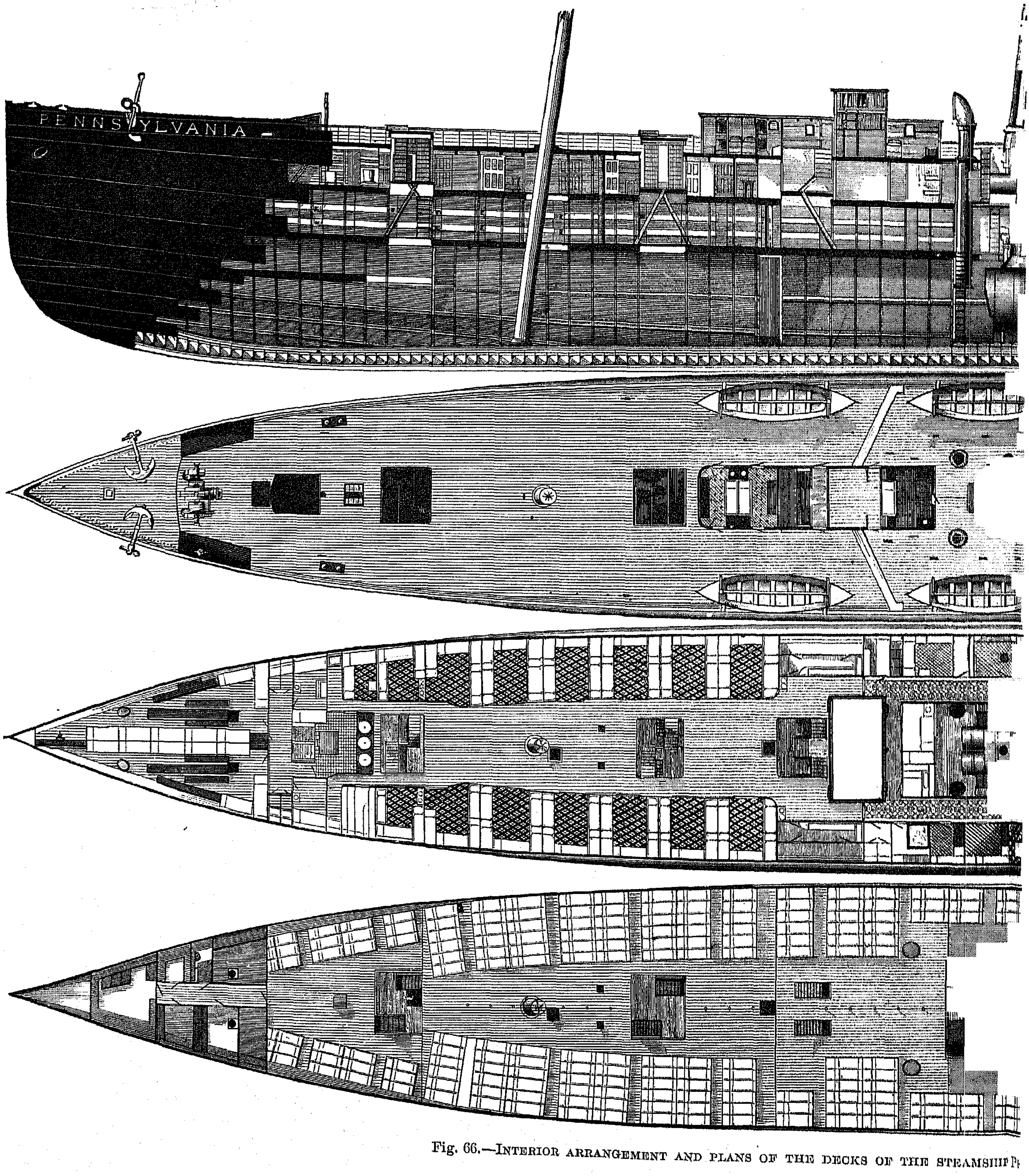
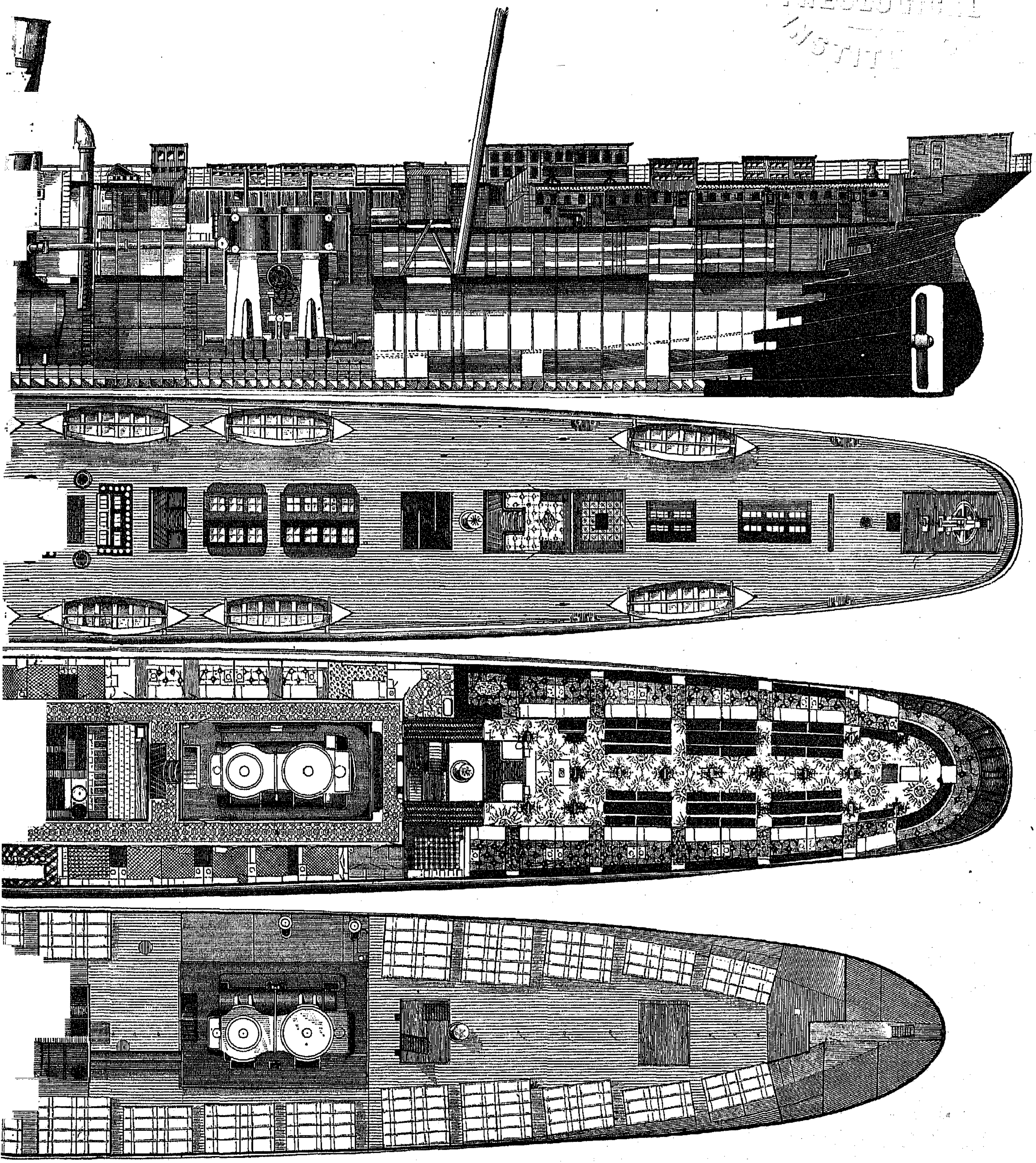


Fig. 66.—INTERIOR ARRANGEMENT AND PLANS OF THE DECKS OF THE STEAMSHIP P



NNSYLVANIA, OF THE AMERICAN LINE FROM PHILADELPHIA TO LIVERPOOL.

The only other man that ever built of iron in Buffalo (besides those now in the business) is believed to be George H. Notter, a tug- and canal-boat builder, who in 1875 constructed an iron steam yacht 100 feet long.

There are now two yards in the city, that of David Bell and the one belonging to the Union Dry Dock Company. Mr. Bell was originally a builder of boilers and engines, and machinery still constitutes the largest part of his yearly product. In 1861 he ventured to build the screw steamer Merchant, of 720 tons, 200 feet long, 29 feet beam, and 14 feet hold, and has since taken such contracts as could be secured for yachts, tugs, and small propellers. Three of his vessels, launched in 1871 and 1873, were the revenue-cutters Albert Gallatin, of 250 tons; Alexander Hamilton, of 250 tons; and G. S. Boutwell, of 198 tons—all propellers, and all afterward sent to stations on the Atlantic coast, where they have remained in service. Up to 1882, 26 iron vessels had been built at this yard, all steamers, and two yachts and a tug included in the number were being completed in the fall of 1881. Ten of the whole number were yachts, and some of these boats were plated with steel $\frac{3}{16}$, $\frac{1}{4}$, and $\frac{5}{16}$ inch thick, in order to lessen their weight, the cost of steel at Buffalo being only slightly in excess of iron. Mr. Bell has built of both wood and iron, and says that he has been able to construct tugs of the two materials which scarcely varied in cost. For instance, a wooden tug built in 1876, 70 feet long, 16 feet beam, and 8 feet hold, cost $12,500 to build and equip, whereas he was able to build one iron tug of 64 tons, 76 feet long, 16 feet beam, and 8 feet hold, at a cost of $13,000 only; and he believes that the development of the iron industry of the lakes will in time reduce the cost of materials for large vessels to a point where iron steamers can be built at so nearly the price of wooden ones as to supersede entirely the latter style of boats. He paid 4 cents a pound for angle-iron in 1875 and $2\frac{3}{10}$ cents in 1881; for plating he paid $3\frac{1}{2}$ cents in 1875 and $2\frac{7}{10}$ cents in 1881.

The tug on the stocks in the fall of 1881 was 90 feet long, 18 feet beam, and 10 feet deep in the hold, $11\frac{1}{2}$ feet molded, and was built with 37 tons of iron in the hull. Like all of his small boats, she has a bar-iron keel and stem $4\frac{1}{2}$ by $1\frac{1}{2}$ inches. The stern-post is 6 by 2 inches, tapered in the fan-tail to $1\frac{1}{2}$ inches. The frames are 3 by $2\frac{1}{2}$ by $\frac{3}{8}$ inch, spaced 18 inches; floor plates, $\frac{1}{4}$-inch iron. The deck beams are of white oak, 4 by 4 inches, the short ones near the boiler and engines being 3 by 4. The plating is all $\frac{3}{8}$-inch iron. Two iron bulkheads cross the boat of $\frac{3}{16}$-inch plate, stiffened with $2\frac{1}{2}$- by $2\frac{1}{2}$-inch angle-iron. The plank-sheer and bulwarks are of heavy white oak, while the deck and house are of white pine. There is only one boiler, 8 feet in diameter and 16 feet long, and one engine, with 24-inch cylinder and 26-inch stroke. Steam is used at high pressure, 120 pounds being allowed. An 8-foot screw wheel is fitted at the stern with 13 feet pitch, the shaft being of steel $6\frac{3}{4}$ inches in diameter. In model the tug was fuller than those used in Atlantic coast harbors, and cost complete about $19,000. In order to fit her for ice breaking in the harbor of Toledo the stem was not given the usual curvature, but, while perpendicular above the water, raked sharply below at an angle.

One of the new yachts was 106 feet long on deck, 17 feet beam, and 11 feet deep, frames spaced 18 inches, scantling light throughout, with white-pine beams resting on an iron shelf, wooden deck, and 4 transverse water-tight bulkheads.

The Union Dry Dock Company has long been a builder of wooden propellers of the largest class, but its managers in 1881 put into their large yard the plant for making iron vessels. The first boat, finished in 1882, was the propeller H. J. Jewett, a two-decker of 1,953 tons, 285 feet long over all, $265\frac{1}{2}$ feet on deck, $39\frac{8}{12}$ feet beam, and $25\frac{1}{2}$ feet hold, with houses on the upper deck. She was built of the ordinary lake model, and was given a double bottom, in order to carry water ballast when returning to the upper lakes light, and also in order to save the vessel from sinking in case she should strike a rock in making the Lime Kiln crossing above Detroit. Seven water-tight bulkheads were put in across the ship. She was furnished with two steel boilers and two compound engines of 1,000 horse-power, capable of driving her at a speed of 15 knots. Her carrying capacity is 2,400 tons. The iron plating of her bottom is $\frac{5}{8}$ and $\frac{9}{16}$ inch thick on her bottom, $\frac{1}{2}$ inch on the sides, and $\frac{9}{16}$ inch between decks. The frames are 3 by 4 inch angle-iron, spaced 21 inches; reverse bars, 3 by 3 inch. The floor plates are $\frac{7}{16}$ inch. The company has now on hand two iron vessels. The revenue-cutter Fessenden has been hauled out on the stocks, and an entirely new iron hull of substantially the same model is being constructed in place of the old wooden one. The boat is 188 feet long, 28 feet beam, and 12 feet hold. A new boiler will be put in, and the engine repaired. The other vessel is a new tug, 65 feet long, 15 feet beam, and 8 feet hold.

Cleveland is one of the most noted wooden-ship yard centers on the lakes; but here, as at Buffalo, attention has lately been turned strongly to the advantages of iron tonnage. The Globe iron works have been for many years making machinery and boilers for lake boats on a large scale, and in 1880 the owners prepared to extend their plant sufficiently to undertake the building of iron hulls. The main works are situated in the city, near the lake, close by Presley's dry-dock. Having bought a half interest in the dock, the company located a ship-yard in the western edge of the city and put in an outfit of shops, planers, punching machines, frame-bending apparatus, rolls, etc. In 1881 they raised the frames of their first vessel, a large lake propeller (Fig. 67). The ship was completed in the spring of 1882, and launched at the opening of navigation. The following are points of interest in her construction:

The vessel: screw propeller, $302\frac{1}{2}$ feet long on the spar deck, 288 feet between perpendiculars, 39 feet beam, 25 feet from spar deck to base line, with double bottom for water ballast. Fall home of the topsides at plank-sheer, 8 inches. Weight of vessel with all on board, 950 tons; cargo on 14 feet draught, 2,770 tons; coefficient of displacement, 80 per cent.

Keel.—Flat plate, 2 feet wide, $\frac{11}{16}$ inch thick.

Frames.—Angle-iron on the floor, 3 by $3\frac{1}{2}$ by $\frac{6}{16}$ inches, weighing about 8 pounds to the foot; top timbers from the bilge upward, 3 by 4 by $\frac{6}{16}$, weighing about 9 pounds to the foot. Reverse angles, 3 by 3 by $\frac{3}{8}$ inches. Floor plates of $\frac{5}{16}$ iron, 16 inches deep on the keel, 14 inches at the lower turn of the bilge, increasing to 20 inches in the molding near the upper turn of the bilge; the floor plate ends at a point 40 inches above the base line of the keel. Partial bulkhead plates are carried on a certain number of top timbers, 23 inches wide at the foot, 12 inches wide at the upper deck, and $\frac{7}{16}$ inch thick, with reverse angle riveted to the outer edge of the plate. The deck of the double bottom is stiffened by single 3 by $3\frac{1}{2}$ inch angle-iron floor frames, which are connected to the top timbers and reverse angle-irons of the partial bulkhead by curved angle-iron futtocks.

Keelsons.—One main keelson of $\frac{10}{16}$-inch iron, $3\frac{3}{4}$ feet high, continuous fore and aft, cutting through all floor plates, riveted to the latter with 3 by 4 by $\frac{6}{16}$ angle-iron clips, and stayed to them on each side by channel-iron struts, riveted to the floor plate and the vertical clip. The foot of the main keelson is fastened to the keel and gutter plate by angle-irons 4 by 4 by $\frac{7}{16}$ inches; the upper edge is stiffened by reverse angle-irons 3 by 4 inches, riveted on each side, flat flanges uppermost. There are three side keelsons on each side of the main keelson, spaced $4\frac{1}{2}$ feet apart, and corresponding in height to the main keelson. They support the deck of the double bottom, and allow of

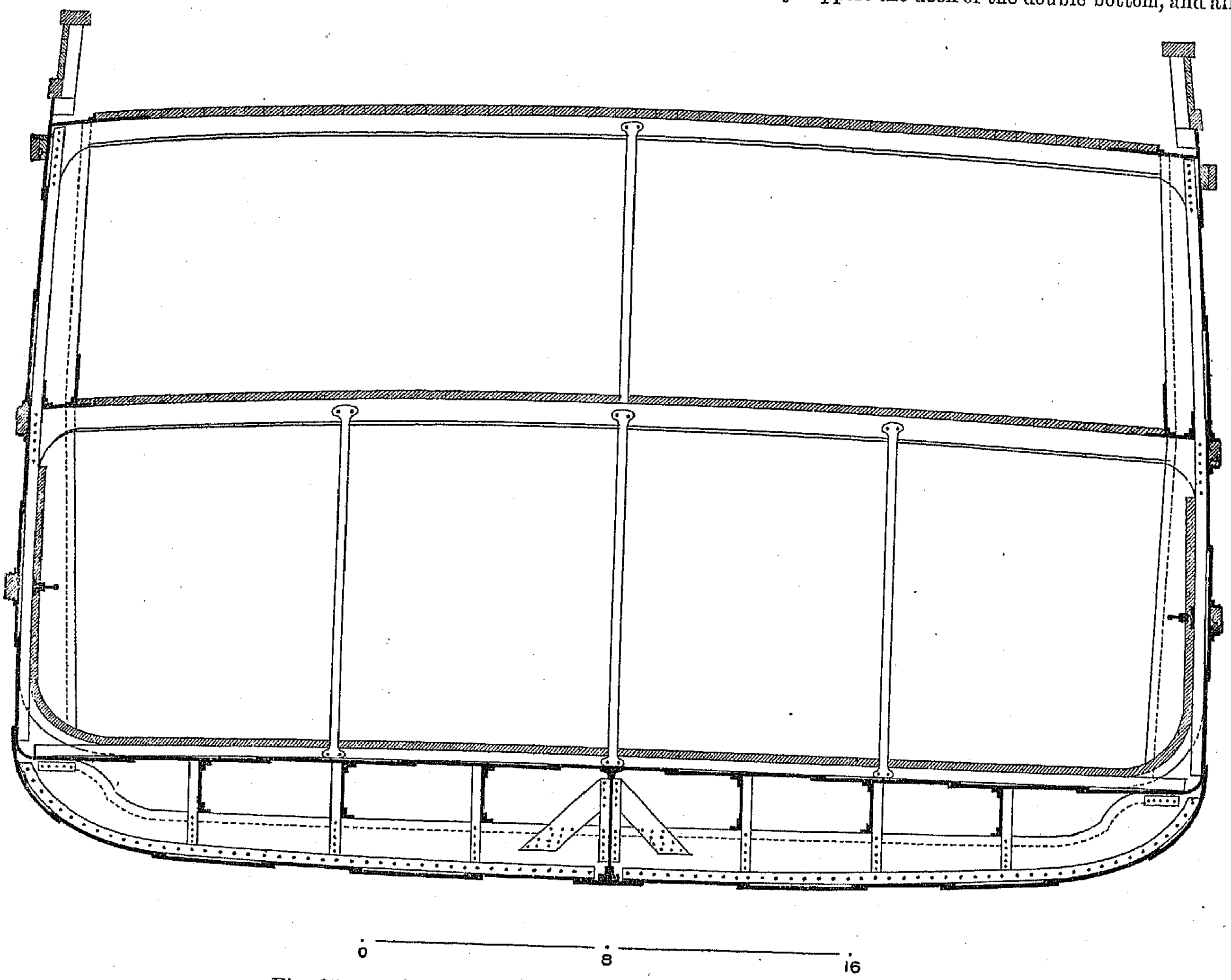


Fig. 67.—Midship section of an iron propeller, northern lakes.

Built by the Globe iron works at Cleveland, Ohio, in 1881–'82. Length over all, $302\frac{1}{2}$ feet; breadth, 39 feet; molded depth, 25 feet; displacement on 14 foot draught, 3,714 tons.

a crown of about 3 inches in the double bottom. Side keelsons of $\frac{6}{16}$-inch plate, fitted intercostally riveted to a vertical angle-iron 3 by 3 inches at each floor plate, the angle-iron reaching to the top of the keelson, and also to a continuous horizontal angle-iron, same size, which is laid upon and fastened to the top edges of the floor plates. One angle-iron, 3 by 3 inches, along the upper edges of the side keelsons.

The double bottom, or water-ballast deck, extends from the collision bulkhead to the engine bulkhead, with a capacity for 700 tons of water. It is divided into 6 compartments by transverse bulkheads. The deck of this bottom is of $\frac{1}{2}$-inch iron plates, $4\frac{1}{2}$ feet wide, laid in fore-and-aft streaks, the center of each streak laid on one of the keelsons, and the edges riveted and water-tight. The edges of the plates next the sides of the vessel cut through the frames, curl upward, and lap 6 inches between the edges of two streaks of outer plating, the rivets of that seam going through the three thicknesses of plate. By this device and the angle-iron futtocks within the double bottom is firmly united to the rest of the ship. Angle-iron floor frames are laid across this deck of the double bottom, and upon them is laid a floor of 1-inch white pine, and on that a floor of 2-inch oak plank, breaking joints with the pine. The lower hold is ceiled on the sides also in this manner.

Plating—Out and in; $\frac{9}{16}$ of an inch from keel to the lower deck; then $\frac{1}{2}$ inch; sheer streak, $\frac{5}{8}$ inch, rising one foot above the upper deck beams.

Beams.—Lower deck, bulb **T**-iron, 10 inches deep, with angle-irons $3\frac{1}{2}$ by 6 forming the flanges. Upper deck, bulb **T**-iron, 8 inches deep. Stanchions to lower deck, $3\frac{1}{2}$ inches in diameter; upper deck, $2\frac{3}{4}$ inches.

Stringers.—Hold stringer on frames half-way between bilge and deck beams, bulb T-iron, 10 inches deep, with angle-irons $3\frac{1}{2}$ by 6 for the upper flanges. Flat stringer plate on ends of lower deck beams, 18 inches wide, $\frac{7}{16}$ inch thick; vertical plate 12 inches wide, $\frac{3}{8}$ thick on frames, the two plates united with 3 by 3 iron in the angle. Broad stringer plate of $\frac{5}{8}$-inch iron on the upper deck beam ends. Tie plates on lower deck beams, $\frac{7}{16}$ by 12 inches.

Decking.—White pine, 4 by 6 inches on the lower deck, $3\frac{1}{2}$ by 6 on the upper.

Fenders.—Three in number, one at the 9-foot water line, oak, 5 by 8 inches square, held between 3- by 3-inch angle-irons, one opposite the lower deck, oak, 5 by 8 inches, held between 3- by 4-inch angle-irons, and one, 8 by 10 inches, at the upper deck, fastened to the sheer streak.

Boilers.—Two, $8\frac{3}{4}$ feet in diameter, 18 feet long, tested to carry 100 pounds of steam.

Engines.—Compound, with 30- and 56-inch cylinders and 4 feet stroke, acting on cranks at right angles to each other, placed away aft. Two double hoisting engines on the spar deck to handle freight. Duplex steam-pump for water ballast, double-cylinder steam steering apparatus, and steam windlass.

Miscellaneous.—Transverse bulkheads, iron coal bunkers, iron house on deck over the boilers. A wooden cabin aft for crew, and another cabin in the bow for the captain and mates, with pilot-house above. Three masts.

From 150 to 175 tons weight are added to the vessel by the double bottom.

In Chicago there has never been much of anything done in the way of iron-ship building, or, indeed, in any other branch of the general industry, except repairing. In 1881, however, an iron tug was constructed at the yard of the Dredging and Dock Company, the first in the city. A Norwegian who had had some experience in iron-ship yards in his own country was employed to superintend, and a few mechanics were brought from Norway to do the work. The boat was 77 feet long on the keel, 88 feet over all, 18 feet beam, and 11 feet deep, and the model was that of the ordinary keel tug-boat. The ship-yard plant was very simple, and comprised only a rough shed, a furnace or two, a steam-engine, a frame-bending plate, and a few drills. The lack of a punching machine was supplied by hand-work and a steam reamer and drill. This handy tool, not yet generally used in American yards, was worked by a light wire rope running out from the shed, and was taken from place to place in the tug wherever rivet holes had to be bored and countersunk. The tug cost complete about $22,000. While the dredging company built the boat for its own use, the intention is to develop a business in iron-vessel building when the times warrant an effort in that direction.

The principal iron-ship yard of the lakes is at Wyandotte, Michigan, a short distance below Detroit. This yard was established in 1870 by Frank E. Kirby, C. E., formerly of the Allaire works, in New York city, for Captain E. B. Ward, who had been making Bessemer steel at Wyandotte ten or twelve years before, and who had on hand a lot of the old steel ingots when the yard was started. Three vessels were built, and the business was then interrupted by the panic of 1873. In 1877 the yard passed into the ownership of the Detroit Dry Dock Company, and it has ever since been actively engaged in the production of iron tonnage under Mr. Kirby's superintendency, 13 vessels having been built down to 1882, all steamers. The following is a list of the boats built:

1871. Propeller E. B. Ward, jr., iron, of 388 tons, 150 feet long, 26 feet beam, and 14 feet deep; now owned at New Orleans and employed for towing.

1873. Tug Sport, steel, of 45 tons, 65 feet long, 14 feet beam, $9\frac{1}{2}$ feet deep, molded; worth $10,000, and owned at Grand Haven, Michigan.

1873. Side-wheel steamboat Queen of the Lakes, iron, now owned on some inland lake.

1878. Side-wheel steamer City of Detroit, composite, of 1,094 tons and 600 nominal horse-power, 240 feet long, 36 feet beam, 14 feet deep-molded; worth $145,000, and owned at Detroit.

1879. Side-wheeler Idlewild, iron, of 312 tons, 140 feet long, 26 feet beam, 10 feet deep, molded; worth $40,000.

1880. Propeller City of Cleveland, iron, of 1,221 tons and 1,800 horse-power, 225 feet long, 32 feet beam, 14 feet deep, molded; worth $155,000, owned in Detroit.

1880. Side-wheel car-ferry Transport, iron, of 1,595 tons and 2,000 nominal horse-power, 265 feet long, 46 feet beam, 79 feet wide over all 17 feet deep, molded, with three railroad tracks on deck. About 120 feet of the boat amidships had a straight body. Boat worth $180,000. Experience with a previous wooden transfer boat, 280 feet long, that cost $230,000, led the Michigan Central Railroad Company to decide in favor of iron for future boats. The Transport was plated with $\frac{5}{8}$-inch iron all over.

1880. Propeller Boston, iron, of 1,829 tons and 750 nominal horse-power, 280 feet long over all, 265 feet long molded, 36 feet beam, and 17 feet deep, molded; worth $170,000.

1880. Propeller Lehigh, of the Anchor Line, iron, of 1,704 tons, 255 feet long over all, 36 feet beam, 17 feet deep, molded; worth $155,000.

1880. Propeller Brunswick, iron, of 1,120 tons, 5 feet shorter than the Lehigh.

1881. Propeller Clarion, iron, of 1,712 tons, 255 feet long over all, 36 feet beam, 17 feet deep, molded; worth $155,000.

1881. Propeller City of Milwaukee, iron, of 1,148 tons; worth $150,000.

1881–'82. Propellers Michigan and Wisconsin, iron, with double bottoms 3 feet deep (the first of their class at this yard), 230 feet long over all, 34 feet beam, and 14 feet deep, molded, and housed on the upper deck the whole length of the vessel.

A representative laker is the Boston, a fine steamer, carrying 83,000 bushels of wheat or about 2,600 tons of cargo on 15 feet draught of water at a speed of 12 miles per hour. The principal data of her scantling are:

Keel.—Flat plate, 33 inches wide, $\frac{3}{4}$ inch thick for 200 feet amidships, tapering to $\frac{1}{2}$ inch at the ends.

Stem.—Hammered scrap iron in one length, size at top $2\frac{1}{2}$ by 6 inches, increasing to $2\frac{1}{2}$ by 8 at the load water-line, and tapering thence away to $2\frac{1}{4}$ by 4.

Frames.—Angle-iron 3 by 4 inches, 9 pounds to the foot, spaced 20 inches. Reverse angles 3 by 3, 8 pounds to the foot, lapping on the floor plates 3 inches and on the frame angle-irons $2\frac{1}{2}$ inches, going on alternate frames to the top height and to the lower deck. A doubling piece of 3 by 3 inch angle, 8 pounds to the foot, on the top edge of the floor plates opposite the reverse angle-irons, going through a score in the keelson plate, and riveted through the floor plate and reverse angle-iron.

Center keelson.—Vertical plate, 21 inches deep over the keel, $\frac{1}{2}$ inch thick.

Floor plates.—Molded at the thwart 21 inches, at the ends 13 inches, $\frac{1}{2}$ inch thick amidships, $\frac{7}{16}$ inch at the ends of the vessel, connected to the keelson plate by 3 by 3 inch angle-iron.

Main keelson.—Vertical plate, 10 inches deep, $\frac{1}{2}$ inch thick, connected to a 26 by $\frac{9}{16}$ inch gutter plate by double angle-irons $3\frac{1}{2}$ by $3\frac{1}{2}$ inch, 10 pounds to the foot, with 3 by 3 inch double angle-irons on the top edge.

Sister keelsons.—Intercostal of $\frac{5}{16}$-inch plates, connected to the floors, and with double angle-irons $3\frac{1}{2}$ by 6 inches, 12 pounds, on the floors the entire length of the vessel.

Bilge keelsons.—Double angle-irons $3\frac{1}{2}$ by 6 inches, 12 pounds, placed back to back.

Beams.—T-bulb iron 9 inches deep, 25 pounds to the foot, on alternate frames; hold beams, channel iron, 8 inches deep, 25 pounds.

Stringers.—Main deck 48 inches wide, $\frac{9}{16}$ inch thick, tapered in width and thickness toward the ends. Hold 16 inches wide, $\frac{9}{16}$ inch thick amidships. Ties on main deck 12 by $\frac{5}{8}$ inches amidships, with plate of the same athwartships on each side of the hatches.

Plating.—Worked in fair lines, in and out strakes, garboards $\frac{3}{4}$ inch; bottom, the same; bilge plates, $\frac{5}{8}$ inch; sides of the vessel, $\frac{1}{2}$ inch; sheer streak, $\frac{9}{16}$, then $\frac{8}{16}$, at the ends $\frac{1}{2}$ inch; width amidships, 54 inches, worked 12 inches above the beams of the deck. Butts and laps double riveted; sheer streak amidships triple rivets.

Bulkheads.—Five in number, of $\frac{3}{8}$-inch iron below the 14-foot water-line, $\frac{5}{16}$ inch above, stayed vertically on one side by 3 by 4 inch 8 pound angle-iron, spaced 3 feet, and horizontally on the other side by angle-irons every 5 feet. Coal-bunkers of 5 pound plate, stiffened with T-iron.

Wood work.—The main deck is housed by means of 5 by 6 inch oak stanchions fastened to the sheer streak, set 30 inches from center to center, and passing through a white-oak main rail 5 by 16 inches. Pine carlines are thrown across, the sides are boarded up with white pine, and the top or spar-deck is planked with $2\frac{1}{4}$ inch decking. Main-deck plank, white pine, $3\frac{7}{8}$ inches thick; hatch coamings, white oak Three white-oak fenders on each side of the vessel. Flooring of hold, two thicknesses of 1-inch pine boards, the bilge covered with 2-inch pine and the sides of the hold with 1-inch pine. One pine mast forward.

On the whole, it can be reported that the building of iron and steel vessels has made sufficient progress in the United States to have created the plant and trained the labor for producing sailing and steam craft for the merchant service of every description and of any size. No facilities exist for rolling and shaping armor-plates of the great thickness now required for iron-clads, but the merchant service is well provided for, and the industry is growing in spite of the high cost of American labor and materials. New yards are continually coming into existence, the general development of American industry is reducing the cost of materials, and the use of machinery is reducing the expenditures for labor upon vessels. The competition in rival yards is lessening the margin of profit for which their proprietors are willing to build, and the tendency is all in the direction of favoring the substitution of iron or steel tonnage in place of wooden. The total quantity of iron yearly consumed by the industry is not large, and should Congress provide the way for placing the American builder on a par with the European builder so far as the cost of iron and steel is concerned it seems probable that the tendency toward the more modern class of tonnage would be greatly accelerated. This industry is a valuable one, nationally, in many important particulars. It robs the country of none of its resources. The exportation of grain, cotton, and tobacco is the shipping away of so many thousand tons of the best constituents of American soil, and the construction of wooden tonnage destroys the forests. There are other industries which effect changes for the benefit of this generation for which future generations will have to pay. Iron-ship building appears to inflict no injury so far as consumption of materials is concerned, and it is a department of activity which employs a greater proportion of human lab or to the value of material used than almost any other which can be named.

CHAPTER VI.—CANAL-BOATS.

Government classification of merchant tonnage is determined by the motive power of the vessels. There are three classes in all—sailing, steam, and unrigged vessels. The latter forms a large and important element in all statistical reports as well as in the ship-building industry, and includes canal-boats, flat-boats, and river barges. The total register capacity of the present fleet of these vessels is larger than is commonly known (because barges and canal-boats are exempt from registration now), and the following is an approximate statement for the year 1880:

Class of vessel.	No. owned in the United States.	Register tonnage.	Value.
Steam	5,139	1,221,207	$80,102,495
Sail	16,820	2,366,183	59,152,950
Unrigged	10,697	2,899,970	16,489,264

It has been convenient to speak of barges and flat-boats in connection with river steamboats, and it only remains to speak of canal-boats, which comprise about one-half of the whole unrigged tonnage. Owing to the rapid growth of railroads the canal system of the country has been somewhat overshadowed in late years. In New England the canals have been superseded, and in one or two cases have been used as the bed of the railroads that took their place. In the middle states a few small and a few branch canals have been given up. However, many important routes still remain in existence in New York, Pennsylvania, New Jersey, Ohio, Illinois, Maryland, and Virginia; some have been enlarged and supplied with a new and superior class of boats, and their resources have been thoroughly utilized. The cheapness of transportation has rendered them valuable to the commercial world, and there has been a great deal of legislation looking toward their preservation, maintenance, and extension.

The population supported by the barges of the United States is not known, but those that live by canal-boat navigation now number about 40,000. Counting those who attend to the locks and keep the canals in order, the number is about 60,000, which is equal to that of the persons engaged in the coasting trade of the United States. The boats numbered 8,771 in 1880, having a register capacity of 1,253,688 tons, and being worth $8,273,255.

NEW YORK STATE CANALS.

The Delaware and Hudson canal, belonging to a company of that name, extends 108 miles from Honesdale, Pennsylvania, to Rondout, New York, on the Hudson river, coming down to the river via Esopus creek, and averages 48 feet wide at the top and 32 feet on the bottom, with 6 feet of water. In 1870 there were 879 boats on this canal, all employed in the transportation of coal from the mines to the river. About a million tons are moved yearly. Coming down from the mines, the boats lie alongside of a wharf in the middle of the creek at Rondout, where the coal is taken out by steam-hoisting apparatus and dumped in immense mounds on the wharf. There are 45 derricks for hoisting coal on the wharf, all operated by one line of shafting, which supplies the power. More than 240 boats are often lying at or near this wharf at one time. The boats all rendezvous at Rondout. There are eight yards at Rondout devoted to canal work, having among them one dry-dock and nine sets of canal railways of four rails each for taking boats out of water. The company has its own yard here, at which it both builds and repairs, and in the census year 42 boats were constructed. The other yards do not often make canal-boats, but prefer to contract for the various classes of barges used in freighting on the Hudson river and Long Island sound, such as coal-barges, ice-barges, boats for cement and brick, and tugs. The barges are either scows or double-end framed boats from 90 to 130 feet in length and 26 to 34 feet on the beam, and the ice-boats have deck-houses the entire length. When not engaged in building the private yards in Rondout are busy repairing; in fact, this latter occupation forms the bulk of their business. New boats are built at the company's yard and at private yards in the country, chiefly at Ellenville, Phillipsport, Port Benjamin, and Alligerville, New York, and Honesdale and Hawley, Pennsylvania. In ordinary years there are from 50 to 70 boats built at these country yards.

The Delaware and Hudson model is what would be called sharp at both ends, and though rather full, it is sharp for a canal-boat. The floor is flat clear fore and aft. There is a deck in the bow and one in the stern of the boat, with a little cabin, 6 feet fore and aft, in the stern. The body of the boat is not decked, but is covered, when necessary, with hatches. The details of construction are prescribed by the company. The boats are 91 feet long from face of stem to outside of stern, 14½ feet beam, and 6 feet deep; sheer, 15 inches forward, 8 inches aft. The scantling is as follows:

Bilge log.—Hard wood, 10 by 10 inches, with $4\frac{1}{2}$ foot scarf, bolted with $\frac{5}{8}$-inch screw bolts. Under the stem- and stern-posts the logs are connected with a strong knee.

Keel.—None; only a heavy garboard.

Floor timbers.—Hard wood, 4 by 5 inches square, spaced 18 inches, let into the bilge log 4 inches. Side timbers white oak, 4 by 5 inches, let into the bilge log 4 inches, spaced 18 inches, but set in the center of the floor-frame spaces; spaced 13 inches in the bow and 15 inches in the stern; side timbers straight.

Keelson.—Oak or yellow pine, 7 by 10 inches square, bolted with $\frac{5}{8}$-inch iron.

Stem- and stern-posts.—White oak 8 by 16 and 13 inches, each with a knee on the keelson, and each with 3-inch knight-heads. The stem rises 10 inches above deck.

Clamps.—Oak, white pine, or yellow pine, 3 by 14 inches, in long lengths, three spikes and one $\frac{5}{8}$-inch bolt riveted on a ring in each timber.

Braces.—Main, oak or pine, 4 by 12 inches, 32 feet long, butting under the midship beam under the clamps, the lower ends resting on the bilge log fore and aft; reverse braces, oak or yellow pine, 4 by 9 inches, two each of the following lengths, 18, 17, 15, 12, and 9 feet, and a brace 5 by 7 inches and 12 feet long, to fit the stem and upper breast-hook, heeling on the keelson.

Beams.—Eight of them white oak, 5 by 8 inches; forward beam, 7 feet from stem; forward cabin beam, 11 feet from stem-post; after-cabin beam, 6 feet from stern-post, the other five beams equally spaced amidships; hanging knees sided 5 inches; carlines of oak 3 by 8 inches.

Decks.—Two-inch white pine.

Plank-sheer.—Oak or yellow pine, 2 by 11 inches

Ceiling of floor.—Two-inch hemlock.

Planking.—Bottom, 2-inch hard wood, with $4\frac{1}{2}$- by $\frac{5}{16}$-inch spikes in each timber; sides, 2-inch oak or yellow pine, 7 inches wide, increasing to $2\frac{1}{2}$ and 3 inches in thickness on the walls.

Breast-hooks.—Oak, sided 6 inches, with braces, two forward, two aft.

Narrow wash-board deck along the gunwales, with white-oak coaming 4 by 9 inches square, and a high coaming of oak or yellow pine bolted on top of that 3 by 8 inches. Hatches made of 1-inch white pine.

Bitts.—Oak windlass bitts forward, and three oak timber heads, 5 by 10 inches, on each side of the boat, fastened to the sides with $\frac{5}{8}$-inch bolts.

Railings.—Aft, oak, 3 by 4 inches, placed edgewise, and resting on 2- by 3-inch chocks, 8 inches long; forward, 14 feet long, 2 by 3 at bow, 2 by 2 at after end, bent round to the curve of the bow and bolted.

Rudder.—Stock, oak, 8 by 12 inches, with 5 iron bands; blade, $6\frac{1}{2}$ feet long, 5 feet wide, 2 inches thick, with batten 2 inches thick and 8 inches wide from after upper corner to heel of stock; batten a foot wide on inboard end; blade cut so as to allow 10 inches drop to rudder.

Guards at stern.—White oak, 5 inches thick, 20 inches wide at stern-post near plank-sheer, supported with 6 knees or chocks, strongly bolted around the curve of the stern with $\frac{5}{8}$-inch iron; stern plank, 6 feet long, 5 by 10 inches, to be let into stern-post and run over and fastened to guard; bumper, 8 by 14 inch oak, to butt the stern plank and guard, strongly bolted; a bar of iron, 4 inches wide, to extend around the guard and bumper, 5 feet each side, and to be continued around to the sides of the boat, with bars $2\frac{1}{2}$ inches wide.

Fenders.—Forward, four on each side, oak, 3 by 4 inches, 14 feet long, bent around the curve of the bow and fastened through the planking into the timbers by 7-inch spikes; irons, $2\frac{1}{2}$ inches wide, $\frac{1}{2}$ inch thick on the fenders, and 14 feet long, fastened with spikes with countersunk heads.

Bilge irons.—Three on each side, both forward and aft, 3 inches by $\frac{1}{2}$ inch, not less than 14 feet long, fastened with spikes with countersunk heads.

Stem iron.—Four inches wide, $\frac{3}{4}$ inch thick, extending from the after side of the stem at the head over the head and down the fore side of the stem, and under the bottom of the boat 2 feet, fastened with 6-inch round spikes, with countersunk heads, 8 inches apart.

Cabin.—White pine, with berths under the stern deck, and roofed with 2-inch white-pine decking.

Paint.—Two coats on the top sides, and over beams, decks, cabins, coamings, etc. Below water, graved with hot tar.

It requires about 21,000 feet of timber to build a boat, viz: 10,500 feet of oak or yellow pine, 5,800 feet of hard wood, 3,200 feet of hemlock, and 1,600 feet of white pine; also 3,800 pounds of iron, 100 pounds of oakum, and $2\frac{1}{4}$ barrels of pitch and tar. Each boat carries 130 tons of coal. The cost of one in 1880 was about $1,200. The company encourages the building of boats by accepting those built at private yards, assigning them to boatmen at a rating of $1,500 apiece and then employing them on the canal. About $20 is deducted from the freight money earned on each trip; from the remainder the boatman pays interest, running expenses, and living. He can pay for his boat in about six years, meanwhile having earned his support, and then has a boat which is good for from four to six years longer as his own property. A good feeling exists between the men and the company. Both parties make money, and between them they maintain a building and repairing industry which is of considerable local value. In all there are about 25 yards on the canal, producing yearly about 50 or 60 boats and doing about $100,000 of repair work. In 1880 the company had $540,000 invested in boats and barges, ten of the latter carrying 560 tons each.

In the northern part of the state of New York the yards build boats suitable only for the Erie canal, save those on the Black River canal, which is one of the branches of the Erie, and is the one of least capacity. The Erie canal is $365\frac{1}{2}$ miles in length, extending from Albany, on the Hudson river, to Buffalo, on lake Erie. The average prism is 70 feet wide across the top and $52\frac{1}{2}$ feet across the bottom, with 7 feet depth of water, allowing a draught of 6 feet for loaded boats. The locks are 110 feet long and 18 feet wide. The canal, completed in October, 1825, and opened for business in 1826, now gives employment to 4,350 canal-boats, 18,000 horses and mules, and about 20,000 men. The speed of the boats is limited to 4 miles per hour, but with horses moving at a walk, and with the detentions at the numerous locks of the canal, boatmen think they do well if they average 2 miles. The large boats each carry from 7,600 to 7,800 bushels of wheat, or 240 tons of coal, on one trip, or from 160,000 to 170,000 feet of lumber. To the length of the main line of the Erie canal must be added the 155 miles of Hudson River navigation to New York city and the length of the branches of the Erie which still remain in use. Some of these branches have been abandoned within the last five years as being of small capacity and having a commerce insufficient to warrant the expense of maintaining them; but there are still in operation the Champlain canal, connecting Albany with lake Champlain, 66 miles long; the Black River branch from the Erie at Rome, 78 miles long; the Cayuga and Seneca canal, 25 miles; the Oswego canal, 38 miles; the Oneida River improvement, 20 miles; also a part of the Chemung canal, 23 miles, although officially abandoned. There are several lakes in central New York, each about 40 miles long, which are navigated by canal-boats, and are virtually branches of the canal, namely, Oneida, Cayuga, and Seneca. The total of canal navigation of the Erie system thus amounts to about 860 miles. Before the war there were navigating these waters from 2,200 to 3,500 horse-boats, the number fluctuating with the activity of trade, the clearances varying from 80,000 to 104,000 a year. New boats were built in different years as follows:

	Tons.
1844	378
1846	477
1847	1,466
1848	457
1849	215
1850	152
1851	213
1853	590
1854	760
1858	255

During and since the war trade between the West and the East has grown enormously in volume, owing to the large exportation of grain and provisions which has been developed, and in consequence all the transportation lines from the West to the sea-coast have been crowded with traffic and the business of the Erie canal has about doubled. The number of boats built yearly is about 600. Owing to the large size of the modern boats the number of clearances is not so large as formerly, although the traffic has doubled. In 1880 the clearances were about 70,000.

The Black River canal was originally little more than a feeder upon which the Erie depended for a supply of water; but of late years the lumbermen, who are busily at work in the outskirts of the Adirondack region cutting spruce, hemlock, and hard wood, have found this branch a valuable route for getting their product down to market, and it has grown in importance. Every year during the warm months large rafts of lumber in the log are towed down by teams of horses, and some of the stuff is shipped by boat. The boats are small, bluff-bowed, carrying 90 tons each on 4 feet of water, and cost about $1,100 each. Not more than 10 or 15 are made yearly. There is no oak or white pine of any consequence in the region, and what is used of that kind of timber comes by way of the Erie canal from the West. Builders use the native lumber, hemlock and hard wood, as much as possible. Hemlock costs no more than $7 and $8 per thousand feet; spruce, $9 or $10, sawed.

In the lake Champlain region a large tonnage of canal-boats is employed in the business of the lake, and the principal freighting is done in carriers of that class. Iron ore comes down from Port Henry and lumber from the Canadian markets, both going to Troy, Albany, New York, and other points along the Hudson river and westward on the Erie canal. Steam tugs bring the boats down the lake, and they are then sent through the canal to the Hudson river by teams of mules and horses and forwarded on down the river in fleets drawn by tugs and side-wheel tow-boats. June 1, 1880, the following tonnage was enrolled and licensed in the district, every boat liable to trade to Canada being documented:

	No.	Tonnage.
Canal-boats	510	40,175
Schooners	27	1,730
Wooden steamboats and tugs	10	912
Iron steamboats and tugs	2	137
Barges	5	353
Total	554	43,307

The building points are Fort Ann, Ticonderoga, Whitehall, Essex, Crown Point, and Champlain, and there is one yard at each place, about 90 men being employed in all. The yearly product is about 90 boats, worth from $2,500 to $3,000 each, and registering from 110 to 125 tons. They are of the regular Erie canal pattern. At the Ticonderoga yard the owners build for themselves. In 1880 they had from $50,000 to $75,000 invested in canal-boats. They were preparing to put about $30,000 more into 15 new boats in 1881. Their craft are each 98 feet long, 17¼ feet wide on the floor, 17⅝ feet on the beam, and 8 feet deep, decked, and carry 150 tons on 4 feet and 250 tons on 6 feet draught.

On the Oswego Branch canal, running from the Erie canal to lake Ontario at Oswego, there are 10 yards, employing about 60 men, building a few boats every year, and doing a good business in repairing. These boats are of the largest sizes, and the harbor at Oswego is always full of them. They take part in the grain, the coal, and the lumber trade, and a large number of them, being engaged in the foreign trade, are enrolled and licensed at the Oswego custom-house. The fee for measurement is about $12 per boat.

On the Erie canal proper there are 80 yards scattered along all the way from Albany to Buffalo, employing an average of about 1,200 men for ten months in the year and producing from 300 to 400 boats yearly, while also enjoying a large business in repairing the 4,350 boats owned on the canal and its branches. In the early years from 1825 to 1860 timber was abundant in all the counties through which the route ran, and building and repairing were both well diffused along the course of the canal; but the land has now been cleared off and brought under a high state of cultivation, oak, pine, and hard wood are scarce and dear in many counties, and the result is, that while all the yards do a certain amount of repairing business the building of new boats is tending to concentrate in Rochester, Lockport, Tonawanda, and Buffalo, where timber can be obtained from the West at relatively lower prices than on the eastern portions of the canal.

The little old-time shapely boats with good bows, carrying 30 tons of cargo on about 3 feet draught of water and moving along briskly in tow of two or three horses, are now no longer seen on the Erie canal. The smallest of the horse-boats are the few that come down from the Black River branch, or those which occasionally stray up into this part of the state from Rondout, each carrying from 90 to 130 tons of freight; but where there is one of these boats there are a hundred of the class belonging to the Erie canal proper, large, heavy, almost box-shaped craft, bearing from 200 to 250 tons of goods on 6 feet of water and moving slowly along in tow of two horses. One of the old fashions was to build canal-boats with square, raking ends, and it was only abandoned in 1855 upon the peremptory command of the state authorities, issued to prevent them from injuring each other with their sharp corners. A regulation was adopted in May of that year forbidding any new boat to navigate the canals of the state unless it should have a round or elliptical bow, described with a radius of not less than $8\frac{2}{3}$ feet. In order to give a boat all the capacity the law will allow, builders sweep in the curve of the bow with just about that radius, cutting off the sterns abruptly, so that the cubical contents come within 10 per cent. of that of a perfectly square box. It is only since steam has been introduced into canal-boats that bows and sterns have been given a better shape, but the sharper form is still confined to steam craft entirely.

A good canal-boat (Fig. 68) ought to last fifteen years, but it must be taken care of; the majority disappear in about ten years. On the other hand, there are plenty of boats running that are from twenty to thirty-four years old, well built of choice materials in the first place, and well taken care of by their owners since.

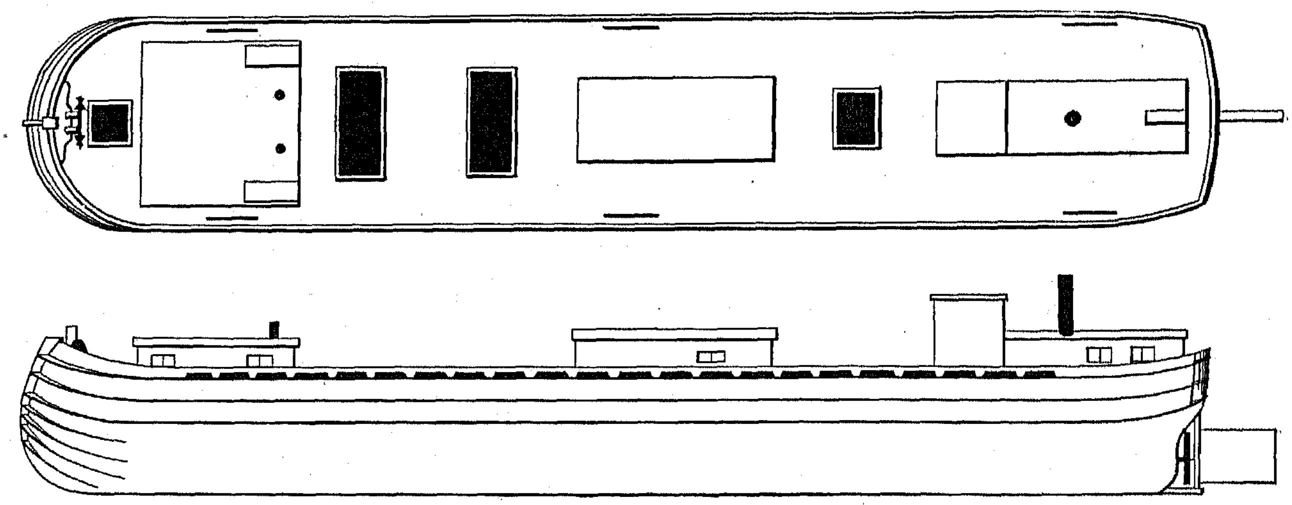


Fig. 68.—Steam canal-boat, Erie canal.

98 feet long, $17\frac{2}{3}$ feet wide, and 10 feet deep. The hull is that of a laker, and represents the general style of the decked boats of the Erie canal.

A great many different varieties of boats are run on the Erie canal, all of them being specimens of four principal types, namely, the scow, the laker, the bull-head, and the steam canal-boat.

The scow is a straight, open boat, sometimes framed, but usually with solid sides, built up of white-pine logs 5 inches thick and from 12 to 14 inches wide, scarfed, closely fitted together and fastened by long iron rods or bolts $\frac{1}{2}$, $\frac{3}{4}$, or 1 inch in diameter, spaced from 16 to 19 inches, according to the fancy of the builder, driven clear through from the topmost "gunwale" to the bottom of the bilge log. The sides are made on wooden horses and fastened, and are then raised to a perpendicular position with a derrick, and the sheer is given by a log properly trimmed. The floor is made by placing single frame timbers across the boat 4 by 6 inches square, spaced about 12 inches, perfectly straight, letting the ends into the bilge log, and planking the bottom with oak or hard wood. About six stout oak beams are fitted in at equal distances apart to strengthen the top of the boat. A short, round, smooth bow is put on by setting up 4-inch frame timbers, molded to the proper curvature, and planking them horizontally from side to side. Four iron bands or straps are spiked upon the fore foot, connecting the bow with the bottom. The stern is short, round, and regularly framed. There are usually a small deck forward, a narrow wash-board along the gunwales, and a small cabin with steering deck aft. Windlass bitts are fitted into the extreme bow, and a small house is built there for the stable, a necessary feature of a horse canal-boat; for while one team of horses is towing the boat, another team must be quartered on board feeding and resting. Three light strips of iron are fastened to each side above water for fenders. Scows are now 98 feet long over all, 17⅝ feet beam, and 9 or 10 feet deep on the side, and weigh from 40 to 45 tons, and will carry 240 tons of cargo each, or from 160,000 to 180,000 feet of lumber, on 6 feet draught of water. They register from 102 to 118 tons. Originally small and built like flat-boats, they have grown in size with every enlargement of the locks of the canal and depth of the channel until they have reached the dimensions given. Scows are best adapted for carrying coal, lumber, barrels of apples, and goods not easily damaged by the weather. They are sometimes framed, and when so built are usually ceiled on a plan calculated to give longitudinal strength. The ceiling is put on in curved lines, the foot of each curve touching the bilge log and the arc rising in the center. Over this ceiling is another, about four streaks of plank wide, the center of the arc touching the bilge log amidships and the ends rising to the gunwale at the bow and stern. But few of this style of boats are now built, the "scow side" of solid logs being the preference. It requires from 325 to 400 days of labor to build a scow, and about 18,000 feet of white pine and 10,000 feet of oak, and 3,500 pounds of round iron, 2,000 pounds of flat bar iron, 1,500 pounds of spikes, and 600 pounds of castings, or nearly 4 tons of iron; but some builders fasten more strongly and use from 4½ to 5 tons. The cost of a scow is from $2,600 to $2,800, varying with the times; it varies also with the extent to which it is decked over. The scow proper is an open boat, but is sometimes one-quarter decked over and sometimes half decked.

The laker is a regularly-framed boat, with perfectly flat bottom, square bilge, perpendicular sides, straight body, round bow and stern, and decked entirely over. It is made of oak and white pine, but if hard wood can be obtained in the locality the latter is used in the bottom planking, as it wears smoother. Sometimes the laker is made with scow sides, but molded at bow and stern, a boat thus built being four or five hundred dollars cheaper. Nevertheless the preference is for a framed boat. The lake boat has about the same dimensions as the other boats of the Erie canal, but is deeper than the scow, and it is 97 or 98 feet long, 17½ or 17⅝ feet beam, and 10 or 10½ feet in depth of side. The scantling varies slightly with the fancy of the builder or the stuff which he can buy to advantage, but a fair description of the laker as built in large yards is as follows:

Stem- and stern-posts.—Oak, with 2-inch oak plank aprons; stem, 13 by 14 inches at the head.

Keel.—None, only a heavy garboard plank.

Frames.—Floor timbers oak, single, 3 by 8 inches, 17 feet long, or clear across the boat, spaced 15 inches; side timbers, 3 by 5 inches, 10 feet long, joined to the floors by two sawed knees or futtocks, which are about 2 feet long, a foot wide, and 2 inches thick; bow and stern frames heavier, about 4 by 10 inches.

Keelsons.—Main, oak, 10 by 12 inches square, bolted into every floor; bilge keelson, 2 by 12 inches. It is not uncommon to use sticks from 75 to 80 feet in length.

Beams.—Chestnut, when practicable, 5 inches square, with carlines 2½ by 5 inches.

Planking.—Oak, 2 inches thick.

Ceiling.—On floor, 1½-inch white pine; clamps, 2- and 3-inch white oak.

Decking.—White pine, 2 inches thick.

Rail.—A narrow strip of 3-inch oak, resting on thin chocks, in all about 6 inches high. In the bow there is a strong oak chock, 15 inches high and 10 inches thick, running around on the gunwale to the straight body and tapering to 6 inches high, and the same in the stern.

Houses.—One forward for horses, with hatch on top and on side to the deck; one away aft for boatman and his family, rising about 2 feet above the deck-way to allow for windows; all of white pine.

Breast-hooks.—Two in bow and 2 in stern, strongly braced.

Fenders.—Oak, about 7 in number, butting on the stem- and stern-posts, and running around the curve of the bow and stern to the flat of the sides, spiked on, and ironed on the outer surface with 3- by ⅜-inch straps. The fenders are spread apart as they go around the curve, so that the lower ones protect the bilge. There are three wearing streaks along the top sides, being thick streaks of planking, ironed with half-round bars the whole length, 1½ or 1¾ inches wide. Two other straps of light iron are placed on the rail, on the outer and inner edges respectively.

Stern.—Overhang about 2 feet, enough to house the rudder-stock. There are two strong fenders or guards of oak across the overhang at the upper and lower edges of the perpendicular face, being a continuation of wearing pieces around the stern of the boat. They are about 15 inches wide and faced with iron. Between them the stern is usually pierced with a window. A strong chock above the upper guard, on which is painted the name of the boat.

Rudder.—Stock, about 10 inches in diameter; blade, 7 or 8 by 5 feet.

A lake boat, or laker, requires the following materials: 18,000 feet of oak and hard wood, from 20,000 to 22,000 feet of white pine and chestnut, 5,800 pounds of bolts, spikes, and nails, from 1,500 to 2,000 pounds of flat iron, 600 pounds of castings, 10 or 12 barrels of salt, $90 worth of paints and oils, and $50 worth of oakum. From 450 to 500 days of labor are required to complete a boat, and, as labor was $1 75 and $2 a day in 1880, the labor bill on a laker amounted to from $900 to $1,025. These boats are well salted in the bow and stern, on the floor timbers and top sides, register from 125 to 139 tons, weigh from 65 to 72 tons, and carry from 225 to 240 tons of cargo. They are usually painted white, and the stern is often profusely ornamented by a sign-painter, the name and home port being conspicuously painted in gilt and red and blue letters. About one-half of the boats on the Erie canal are of this type. Being good for almost any service, these boats are dispatched with cargoes to points on the small lakes in central New York, and often across lake Ontario and on long voyages on lake Champlain, and are popularly used in forwarding grain from Buffalo and Oswego to New York city via the canal and the Hudson river. Their tight decks and high hatch coamings, covered with tightly fitted hatch covers, protect their cargoes from the wash of an occasional wave. The boats cost an average of about $3,800, varying from $3,700 to $4,200.

The bull-head is either a framed or a scow-sided boat with molded bow and stern, completely housed from end to end. The house rises from 2 to 3 feet above the gunwales, and is decked over on top, there being no deck below, as in the laker. It is considered that this type of boat most perfectly protects grain and other valuable cargoes. It is most in demand when grain freights are high; when coal, lumber, and other coarse freights pay the best scows are in demand, while in other years every one builds a laker or a bull-head.

It is rare that a man builds his own boat on the Erie canal. A few have a number of boats built for themselves, but instances of this sort are not common. The great majority of yards build on contract or speculation, and most of the boats are sold on credit. The canalmen are expected to pay a certain sum down in cash, from $300 to $1,000, as they are able to gain the confidence of the builder, a certain other sum being then paid annually. Women can usually get good credit, a great many boats being owned and run by them; they do not spend their money in dissipation, are good managers, and have the name of being sure pay. Owing to the prevalence of the credit system the large builders always have a great deal of money afloat, as they express it, and run a certain amount of risk, because if the year should be a bad one the boatmen make little more than running expenses and are unable to pay their installments, the boats meanwhile depreciating in value. Good years, however, enable the boatmen to liquidate all arrears and save their investments.

As before stated, the horse packet is no longer seen on the Erie canal. Just before railroads were made through the state of New York travelers journeyed to and fro between the Hudson and the West by way of the canal. Boats were built for this traffic with sharp bows and good sterns, being well fitted up on board with berths and cabins. The horses drawing them were able to go along steadily at a trot, in strong contrast with those of the freighting boats, which toiled along painfully at a walk. Packets still exist on the canal, but they are steamers.

The steam craft of the canal are of three classes: First, the freighting propellers, patterned like lakers, each carrying a little boiler and engine away aft in the stern, leaving the hold amidships and forward entirely clear for cargo, and usually taking a consort, or regular canal-boat, which is pushed straight ahead. Next, the cable-towing boats, employed on the level of the canal between Tonawanda and Buffalo, a distance of 42 miles, the boat carrying only the towing machinery and a supply of coal. Lastly, the packets, which are either propeller launches or small steamboats.

The idea of using steam for freighting on the canal was started long ago, but the first practical boats were built in 1871. The state offered a bounty for a successful steam canal-boat which should be built at small expense and would run alone and without washing a swell over the tow-path of the canal. The prize was a large one, and resulted in the perfection of the Baxter boats, seven of which were built by a company having $100,000 capital. The original idea was to propel these boats with twin screws at the stern; but this plan was abandoned, and the later boats were each propelled by a single screw, having four blades mounted on a large central drum or hub. The state paid $35,000 for the building of the first seven boats, and seven more were constructed soon afterward by the company. The mistake was made of running the boats independently at first. Owing to the competition with the railroads horse-boats were hardly paying expenses, and, as steamers were more costly to operate, they lost money. The result was that the company failed and was sold out, and the boats passed into other hands. It was then found that by taking in tow an ordinary boat, lashing the two together in a direct line, one ahead of the other, the steamer in the rear, the average expense was greatly reduced; and the cost of towing on the Hudson being entirely avoided, the boats have since been operated with profit. The Baxter boats were 96 feet long, 17 feet beam, and 9 feet deep in the hold, and had fairly sharp bows. With 6 feet of water one was able to carry 215 tons of freight, and with $5\frac{1}{2}$ feet 200 tons, making a round trip from New York to Buffalo and return in 16 days, as against 25 to 30 days on the part of a horse-boat. Cost of the trip, about $650. The machinery cost $3,000 and weighed 6 tons.

Another style of propeller is that of the Rapid, a steamer invented in 1876 by Gordon W. Hall at Havana, New York, a little town located a mile from the head of Seneca lake on an old and now abandoned canal. One peculiarity of the Rapid was that the furnace of the boiler was arranged like a base-burner stove. Once filled with coal, the furnace needed no more fuel for eight hours; and it was supplied with contrivances for shaking the grate and controlling the steam, so that the man at the helm could both steer the boat and attend to the engine without leaving his place. The Rapid was 98 feet long, $17\frac{2}{3}$ feet beam, and $9\frac{1}{2}$ feet deep in the hold, the engine, of 35-horse power, occupying with the boiler a horizontal space of 5 by 7 feet only. The coal consumption was 1,600 pounds a day, and the boat and consort were worked by 4 men. The Rapid carried 100 tons of coal from Havana by way of the lake and canal to Buffalo. She then took 8,000 bushels of wheat to Rochester, and then made several trips to New York with 7,700 bushels at a time. The time of the trip from Buffalo to New York and back again, towing two boats from Troy to New York, was from 16 to 19 days, and the total expense of the whole round trip, including tolls, insurance, and port charges, was $310. She made round trips with a consort from Buffalo for $600. The machinery of the Rapid was designed for fitting into any canal-boat by a slight alteration of the stern, and cost $1,800. Mr. Hall built several boats at Havana carrying his machinery, each one costing $6,000 complete, and then in 1880 introduced the idea into Lockport. No alteration is caused in the construction of canal-boats by putting in the propeller machinery except to give the stern a few feet of overhang and to change the location of the captain's cabin. The space in the stern occupied by the cabin in horse-boats is consumed by the machinery in the propeller and by the little house built to shelter it and the steersman. The stable being abolished, the captain's cabin is moved forward to the bow. The boats may be framed or built with scow sides. Three were built at Havana in the year 1879–'80 with 4½-inch scow sides of white pine, hard-wood bottoms, and framed bows and sterns planked with 2-inch white oak. Each took 12,000 feet of hard wood, besides 5,500 feet of oak, and 19,000 feet of white pine, with 4 tons of iron and 5 tons of machinery, and cost $6,000.

The cable boats carry no freight, but are exclusively employed in towing horse-boats between Tonawanda and Buffalo. They are each 80 feet long, 15½ and 16 feet on the beam, and 8 feet deep, drawing 5 feet of water. The principle on which they act is a novel one in America, but is in use on rivers and canals in Europe under the name of the Belgian system of cable towing. A steel wire cable, an inch in diameter, weighing 9,000 pounds to the mile, is laid on the bottom of the canal, with no anchorage except that given by its own weight. On one side of the towing-boat, outside the hull, a series of wheels, five in number, are hung on horizontal axles. The first wheel, near the bow, is 20 inches in diameter; it underruns the wire cable and lifts it from the canal bottom. Three others are amidships, and the cable passes under the first one, a tension wheel 6 feet in diameter, then over the center one, a grooved wheel 5 feet in diameter, and then under the third, another tension wheel 6 feet in diameter. The cable then runs over a 20-inch pulley at the stern of the boat corresponding to that in the bow and falls back to the bottom of the canal again. All the wheels play loosely on their axles except the grooved one amidships, which is rotated slowly by the power inside the boat, and by its grip on the cable hauls the tug, with its tow of six boats, along at a speed of about 3 miles an hour. The tug is supplied with two engines, one of 20-horse power to haul on the cable, and another of 10-horse power, driving a small screw-wheel at the stern of the boat, for use in emergencies only. Eight of these boats built at Lockport in the census year cost $8,500 each.

Business was dull in the boat-yards of the Erie canal in 1879 and 1880, as they had not escaped the general depression following the panic of 1873, and had in addition been subjected to the effects of the severe competition of the railroads. Boatmen, in consequence, felt poor in 1879 and 1880. They starved their boats during the period of low freights, avoiding every expense, and went right by the boat-yards continually, pumping water out of their leaking boats, instead of putting them into some dry-dock and having them repaired. They have had better years since.

On the eastern part of the canal there was not much building of new boats in the census year, and indeed there is not much in any year now, the chief reliance of buyers in that region being on the lake Champlain yards. The places that still do some building on the canal are Albany, West Troy, Crescent, and a few little yards around Oneida lake. In good years from 30 to 50 boats are launched among them. The other yards from Albany to Syracuse did little except repairing. Between these two cities ordinarily no boat need journey more than half a day without coming in sight of some little dry-dock or a yard where it can be taken out of water and have damages repaired, the principal places being West Troy, Crescent, Schenectady, Port Jackson, Little Falls, Constantia, West Vienna, Bernhardt's Bay, North Bay, Utica, New London, Rome, Fayetteville, Canajoharie, Liverpool, and Chittenango. The canal dry-dock is a simple structure, and is placed alongside of the tow-path, or perhaps adjoining the berm bank of the canal. It is often cut out of the solid rock, and is usually nothing more nor less than a lock large enough to hold one or two boats. Any vessel needing repairs is floated in, the upper gate is closed, the water is drawn off, as from a lock, the boat is left high and dry, and the carpenters go to work on it.

Little Falls has two dry-docks, and at each of them there has been in times past much building. In good years from 400 to 500 vessels are docked for repairs. From the books at these yards some data were obtained of the earlier times. Twenty years ago boats were 75 and 80 feet long, 14½ feet beam, and 6 feet deep, drawing 3½ and 4 feet of water, and scows were built with 3- and 4-inch sides. The hills around the town were originally well covered with valuable timber, and supplied the boat-yards with all the oak, hard wood, and pine required. At present there is no timber in the locality. During the war materials ranged high, white pine costing $70 per thousand feet, oak $50 per thousand, and the best $60 and $70. Pitch was 10 cents a pound, once rising to $50 a barrel (it was about a cent per pound, or $2 50 per barrel in 1880). Iron rods were 12½ cents a pound in war times; cut spikes, 10, 12, 15, and 17 cents; wrought spikes, 18 cents; oakum, 15 cents, 10½ cents in 1880. The prices of all materials have declined from 30 to 50 per cent. since the war, and pitch has declined more.

Going westward from Syracuse, there are dry docks at Jordan, Port Byron, Montezuma, Seneca Falls, Rochester, Lockport, Madison, Middleport, Tonawanda, and Buffalo, with small yards here and there at other places. Although 40 miles away from the canal, there are 6 yards at Ithaca, 1 at Trumansburgh, at the head of Cayuga lake, and 2 at Havana, a mile above the head of Seneca lake. The Ithaca yards buy timber to advantage, and build from 25 to 30 large-class boats every year. They are now paying some attention to fitting up their craft with machinery.

At Havana, where a number of steam canal-boats have been made, Gordon W. Hall has a machine-shop as well as a boat-yard. A steamer similar to the Rapid had just been finished when the town was visited in 1880 and lay in the canal drying its paint. It was a full-sized laker, 93 feet long on the keel, 98⅝ feet over all, 17⅝ feet beam, and 9½ feet in the depth of side, scow sided. The forward cabin was 8 feet from the bow, and was 13 feet wide, 14 feet long, and 7 feet high in the clear, extending 28 inches above the deck, containing 5 rooms, and rested partly on the lower breast-hook braces and partly on stanchions, there being a clear space of 4⅝ feet under it available for grain cargo. Amidships there was another house 16 feet wide, 8½ feet fore and aft, rising 3 feet above the deck. In the extreme stern was the engine-house, with a companion-way in the after end. It was 20 feet long fore and aft, 6 feet wide, and 3 feet high above the deck, with a steersman's house in the forward part rising 3 feet higher, a feature peculiar to steam canal-boats, as in horse-boats the man at the tiller stands out exposed to all weathers. The boat was completely decked, and had three hatches.

Nearly all the yards on the main line of the canal from Syracuse to Rochester complained of dull times. In place of from $15,000 to $25,000 worth of repair work yearly, as in old times, each was not doing more than a third or a quarter of that business, and building had virtually ceased, having all been monopolized by Rochester, Lockport, Tonawanda, and Buffalo.

The following yards were found at the places named: Rochester, 5, employing 90 men and building from 40 to 50 boats yearly; Lockport, 4 yards, 160 men, product 60 to 80 boats yearly; Tonawanda, 7 yards, 90 men, from 50 to 100 boats yearly; and Buffalo, 10 yards, 150 men, from 50 to 80 boats yearly. The banks of the canal in the parts of these towns where the yards are present a busy spectacle—new boats under construction, with piles of lumber, and often with sheds, shops, and saw-mills around them; newly painted vessels floating in the canal; dry-docks, with boats going in and out and some high and dry receiving repairs, and a constant stream of traffic moving by in both directions in unending procession. The lumber for the building yards comes almost wholly from the upper lakes, arriving in rafts and ship-loads at the ports of Buffalo and Tonawanda. Oak and white pine, sawed, each cost from $30 to $35 per thousand feet. About one-fourth of the wood is wasted in building a boat. Lakers and bull-heads consume 38,000 and 40,000 feet each; scows, 28,000 or 30,000 feet each.

In Rochester the yards mostly do new work. They sold lakers and bull-heads in 1880 for from $3,700 to $4,200 each, the bull-head being the cheaper boat. Scows were sold for about $2,600.

In Lockport a large repairing business is added to the other branch of the industry. Two firms have each 3 dry-docks, built of masonry like canal locks. Timber is bought at Tonawanda in rafts. The builder who has a saw-mill saves a few dollars per thousand feet by doing his own sawing. Mr. Morgan had been in business for sixteen years, but in 1879 he began anew with a partner and built a large fleet of boats the first year, launching 14 in one day. Morgan & Benedict reported for the census year 22 new canal-boats, worth $3,500 each, and 8 cable-towing boats, worth $8,500 each. In 1880 attention began to be paid to steam on the canal by the Lockport builders, and Mr. Hall, of Havana, came to the city and began the manufacture of his engines, wheels, and boilers, the prospect being fair for the rise of a large fleet of new propellers.

Tonawanda being a lumber market, has great advantages for boat-building, and the yards were all rushing work in 1880. Scows were popular that year, as the port was shipping immense quantities of lumber to the East. One firm, owning a large saw-mill, built 22 open coal barges in the census year, 92 feet long, 17¾ feet beam, and 10 feet sides, at a cost of $2,500 each. A ship-chandlery firm which fits out hundreds of boats yearly with tow-lines reported that a new canal-boat requires 160 pounds of manila rope; those that go out on the lakes or the Hudson river must each have in addition another line 6 inches in circumference and 25 fathoms long, weighing 180 pounds.

At Buffalo there is work for both the canal and the lake; a fact which inures to the benefit of the builders to some extent, as it keeps up the supply of good carpenters, but is probably of greater advantage to the men themselves. The canal yards are strung out along the canal, and are principally engaged in building. Wages are higher in Buffalo than in the country yards, and the owner of an old boat is pretty sure to send it to the place where its repairs can be most cheaply made. Lumber comes entirely from the upper lakes.

CANALS IN THE WEST.

There are two canals in Ohio, the Ohio and the Miami and Erie, both of small capacity, and now falling into disuse. Both are still used for a great deal of small local traffic, and are capable of being converted into valuable routes of transportation by the deepening of their channels. The draught of water available for boats is 3½ and 4 feet, but 6 feet of water in each canal would work a great improvement in their traffic. The Ohio canal runs from Cleveland to Portsmouth, on the Ohio river, a distance of 323 miles. There are 19 miles of feeders and 67 miles of branches. The Miami and Erie canal runs from Toledo to Cincinnati, on the Ohio, a distance of 246 miles, and has 25 miles of feeders. In addition to these two works there is an improvement on the Muskingum river by which 91 miles of that stream above its junction with the Ohio at Marietta are made available for steamers and steam canal-boats. On the two canals the boats freight lumber and ice southward and coal northward, besides doing some general business in the transportation of paper stock, provisions, and general merchandise.

The old-time boats of Ohio were able to carry only about 45 tons of cargo each. They were then, as now, 80 feet long, 14 feet wide, and 4 or 4½ feet deep, drawing 3 feet of water, and were rather sharp and fast boats; but in late years they have been built fuller and given 4 feet draught, so that their capacity has been increased to 80 or 90 tons. They are neat boats, but are not large enough; and, considering that the large 240-ton boats in the state of New York find it hard to hold their own against railroad competition, it is not surprising that the smaller craft of Ohio have been hard pressed since the war, the discouragement among the boatmen being so great that very few new boats have been built for ten or twelve years. About 1870 the old Philadelphia and Erie canal was abandoned, and about 40 canal-boats were taken over to the Ohio canal. There has been almost no building on the latter since, not to exceed 5 or 6 boats being built in any one year.

Steam canal-boats have been tried in Ohio for 20 years. There is a firm at Chillicothe which in 1860 began making engines and propeller wheels for canal and river navigation. Their first boat was a small packet to run on the river to Portsmouth. During the war this boat was employed in carrying cotton from the South, and was finally destroyed. The firm had in 1881 built 50 or 60 canal-boat engines in all, 15 of them at one time, about 1865. So far as the engines are concerned, their boats have been successful. The machinery is light, weighing from 4 to 6 tons only, including boiler and wheel. The Chillicothe wheel has a special reputation in the West, and is much used. It consists of a cast-iron hub, with three short and narrow arms; to these arms are riveted the blades of the wheel, three in number, made of wrought iron, 1 inch thick nearest the hub and $\frac{1}{4}$ or $\frac{3}{8}$ inch at the outer edge. The blades are shaped like truncated triangles, bases outward, and twisted to give them the pitch. The object in putting on wrought-iron blades is to allow of their being promptly detached and straightened or replaced in case of accident. The engines do not act always directly on the shaft, but drive the propeller by means of gearing. Chillicothe machinery, owing to its light weight, is well adapted for river steamers. In 1881 the shops were building a double upright engine to drive twin screws. The cylinders were 11 by 15 inches; the boiler 3 by $16\frac{1}{2}$ feet, made of $\frac{3}{8}$-inch steel, with about 70 flues, and intended to carry 100 pounds of steam. The whole weight, including wheels, was 14,000 pounds, and the cost \$5,000. A set of engines for a 100-foot boat weighed 21,000 pounds, and nine or ten have been made weighing 30,000 pounds each. The cylinders were 11 by 15, 12 by 16, and 15 by 17 inches; boilers about $3\frac{1}{2}$ by 18 feet, steel. While the engines for the canal have done well enough, the boats themselves have not, owing to the small draught of water and the heavy summer growth of grass in the canals. The wheel draws the water away from the after part of the boat and the stern drags on the bottom. With 6 feet of water in the canals these boats would do well; but as they cannot get it, they have all left the canals and gone into river service, what transportation there is being done entirely by horse-boats.

The Ohio boats are all framed, the object being to secure as light a hull as possible. The model is the same as that of the bull-head of the Erie canal. The house is not continuous from stem to stern, but consists of three small houses, one in the bow, one amidships for a stable, and one away aft for the captain, with a little roof or gangway 3 feet wide running from one to another. A few are completely housed, and are called two-deckers. The frames are sawed out of $1\frac{3}{4}$-inch oak, molded 11 or 12 inches over the keel, 9 near the bilge, $4\frac{1}{2}$ on the bilge, and 3 at the gunwale, spaced about 14 inches. There is a light ceiling of 1- or $1\frac{1}{2}$-inch oak or 2-inch white pine. The outside is planked with $1\frac{3}{4}$-inch oak. There are three fenders on the bow, one at the plank-sheer height, the other two a foot apart below, extending around the curve of the bow and ironed with 2- by $\frac{3}{8}$-inch straps. The stem is oak, 12 by 4 inches, ironed on the face with a 3- by 1-inch strap. Houses, white pine. The stern overhangs just enough to house the rudder-stock. About 13,000 feet of wood, a ton of iron, and 80 pounds of manila line are required for one of these boats, and they cost \$1,100 and \$1,200 each.

There are about 15 small yards scattered along the Ohio canal, and less than that number on the Miami and Erie. An old builder is C. H. Payne, of Akron, who spent 30 years in Pennsylvania, and has been 18 years at Akron. He had built 128 boats in all up to 1881, but only one boat in the latter year.

The Illinois and Michigan canal extends from Bridgeport, on the outskirts of Chicago, to La Salle, on the Illinois river, a distance of 96 miles, exclusive of feeders. The channel is 48 feet wide at the bottom and 60 feet at the top, and has 6 feet of water, the available draught for boats being $4\frac{3}{4}$ or 5 feet. There are 15 locks on the canal, each 110 feet long and 18 feet wide. They permit the construction of longer boats than are used anywhere else in the United States. The boats that go through to the Illinois river are 103 feet long, 14 feet wide on the floor, $17\frac{7}{12}$ feet wide on the beam, and 6 feet deep. Of late years a few larger ones have been built for use exclusively on the summit level, extending from Chicago to Lockport, a distance of about 20 miles. These are 120 and 128 feet long, and cannot pass through the locks. In order to assist the dispatch of boats from Chicago through to Saint Louis the state of Illinois and the United States have built two dams with locks in the Illinois river, one at Henry, the other at Copperas creek, making 90 miles of good river navigation with 7 feet of water. Navigation also extends to the Kankakee feeder, 4 miles in length, and on the Kankakee river for a distance of 12 miles. A good farming country extends along the Illinois canal, and considerable grain is shipped to market, and lumber is shipped from Chicago. The trade consists principally of grain, lumber, and stone, but it is the stone business that gives rise to the large boats of the summit level, as extensive quarries are situated along that level and beyond it to a distance of 33 miles from Chicago. Another feature of the freighting is the bringing of ice to the city of Chicago in the summer-time. The largest number of boats run on the canal in a year was 240, in 1863, the number of clearances issued being 7,044; there has been a steady decline in the number of boats from that year to this, the total number in 1881 being 138 boats and the clearances 4,459. This falling off has been counterbalanced, however, by the increase in size of the boats and the faster time made by them. In 1863 there were only 619,000 tons of freight transported on the canal, whereas in 1881 there were 826,000 tons, making the freighting of the year the largest on record with one exception. In 1873 there were 173 boats, and 849,000 tons were carried. Steam canal-boats are now taking the place of the older fashioned craft, as being better suited to the navigation of the river and the summit level. In

1881 there were 24 boats; 7 tugs were also employed. The steamers are 120 and 128 feet long, about 20 feet wide, are strong and handsome, and are oak built, with pine decks and houses. Each is provided with two pretty large engines and twin screws as a rule; the machinery weighs about 10 tons, and has power enough to push one consort and tow one other behind. The stone is carried on deck, the boat having strong bulwarks about 3 feet high to aid in stowing and securing it. Steamers are built every year at a cost of $5,500 and $6,000, and are so efficient that they replace more than their own number of the old horse-boats. In other words, while the change to steam is taking place new boats are not built as fast as the old ones are worn out. There are only three yards on the canal, namely, at Bridgeport, Lockport, and Peru, (*a*) respectively, but the work done is chiefly repairing. Among the ideas tried on this canal was the building of boats with a peculiar stern, to serve as consorts to steamers, the stern being recessed 10 feet or so, so that the bow of the steamer might just fit into it. The idea served no useful purpose.

IN THE MIDDLE STATES.

In New Jersey there are two old and useful canals: the Delaware and Raritan, from New Brunswick to Bordentown, 44 miles, 80 feet wide on top, with 7 feet of water, and the Morris, from Jersey City to Phillipsburg, 103 miles, 45 feet wide on top, with 5 feet depth of water. The traffic in coal is large, and both canals are thronged with boats in the warmer months of the year. Formerly they were supplied with boats by local builders, but the oak and pine have been entirely cut off in the counties traversed by the canals and little is left for the local yards to do except to repair the old boats. The building is done almost entirely in Pennsylvania, in the upper Schuylkill region, where pine and oak still abound among the hills. The New Jersey yards are located as follows: Perth Amboy, 2; New Brunswick, 4; Bordentown, 2; Trenton, 1; Washington, 1.

In Pennsylvania there was originally a large network of canals having a total length of 920 miles. Some of the routes have fallen into disuse, but a few are still in operation, and are important factors in coal and iron transportation, the principal ones being as follows: Schuylkill, from Philadelphia to Pottsville, 108 miles, navigable by boats carrying from 180 to 200 tons; Union, from Middletown to Reading, 85 miles, traversed by 100-ton boats; Tide Water canal, from Columbia to Havre de Grace, 45 miles, 30 miles in Pennsylvania, navigable by 150-ton boats; Pennsylvania, from Clark's Mills to Northumberland, 85 miles, and a line to Huntingdon, 90 miles, 150-ton boats; the north and west branches of the Susquehanna, 50 and 70 miles respectively, 100-ton boats; and Lehigh, from Easton to Mauch Chunk, 50 miles, 120-ton boats; in all, about 620 miles of navigation. It is believed by the state authorities that the time will come when cheapness and not rapidity of transportation will be the great desideratum and the canal system of the state will be reconstructed on a large scale, but at present the tendency is toward a discontinuance of canal navigation. Though millions of tons of the products of the state have been moved to market economically by these valuable water-ways, it is nevertheless true that they would all fall into prompt disuse except that the Pennsylvania, Reading, and Lehigh railroads find them useful auxiliaries in the transportation of iron and coal. On the north branch of the Susquehanna there is one yard at Espy where the Pennsylvania company builds its own boats, and where small steam craft are occasionally launched. At Lewisburg, on the west branch, there is one yard. Other important building places have been Chester, Schuylkill Haven, Landingville, Philadelphia, Hamburg, Reading, Port Providence, Middletown, and Highspire. At Chester the yard has disappeared, and the industry appears to be declining at all the other places named. From 50 to 60 canal-boats are now built annually, whereas in 1871 there were about 150. Previous to 1870 the canal-boats of Pennsylvania were in the main framed boats. Those for the Schuylkill canal were 101 feet long over all, 17½ feet broad, and 9 feet deep amidships, with a draught of 16 inches when light and of 5½ feet when loaded with 180 tons. The bows and sterns were moderately full, but would be regarded as sharp on the Erie canal. The frames, planking, and keelson were of white oak; the ceiling, bridging, deck, and houses of white pine. The cost was from $1,800 to $2,000 per boat. After 1870 the majority of the boats were of the "log bilge" pattern. Those employed on the Schuylkill canal were 102½ feet long over all, 17 feet broad, and 8½ feet deep; capacity on 5½ feet draught, 195 tons of coal; cost, $2,250 each, new framed boats being worth $2,400 each. This was the price in 1873, but in 1879 the price of "log bilge" boats had fallen to $1,750. At Middletown, in 1873, boats of a smaller class were built, 86 feet long and 16½ feet wide, carrying 150 tons, for about $1,650 each, prices varying from year to year according to the times. There is, of course, much repairing of the boats on all the canals; like the other branch of the industry it is declining, but should the long-cherished plans of the state authorities ever be carried out for an enlargement of the canal system, especially for the opening of a first-class route through to the Ohio river, boat building and repairing would awaken to a new activity.

In Maryland there is a canal route 184½ miles long extending from Georgetown to Cumberland, along the valley of the Potomac river. The prism is from 50 to 60 feet wide on top and 40 feet, wide on the bottom, with 6 feet depth of water. The locks are 100 feet long by 16 wide, large enough to pass 120-ton boats. The greater portion of the boats now running on the Chesapeake and Ohio canal, as it is called, are 92 feet in length, 14½ feet wide, 6 and 6½ feet deep, and draw 5 feet of water when loaded. Nine-tenths of all the building and repairing of these boats takes place at Cumberland, where there are six firms actively engaged the year around; the rest of the

a Peru is not strictly on the canal, but on the Illinois river just below the outlet of the canal, which is at La Salle.

work is done at Hancock and Williamsport. Timber is cheap in this region, particularly oak and white pine. Labor is also low, the best men getting $1 50 per day. The boats cost about the same as those on the Delaware and Hudson canal, namely, from $1,100 to $1,300, a few going as high as $1,450, and the labor bill varies from $350 to $450. At Hancock there are two canal dry-docks. Repair work is necessarily a large business on a canal so steadily employed in freighting coal, and contrary to the general rule in these cases labor is only about one-fifth or one-quarter of the expense in boat repairs on this canal. About 60 or 70 boats of the shape usual in Maryland are built at the three places named above in fairly good years, and a certain number of them are apt to be steamers, for the tendency toward steam locomotion has been felt on this canal within the last ten years, and several of the new class of boats are in operation. Their cost is $3,000 each, twice that of a first-class horse-boat; this makes their introduction slow, but their number appears to be growing. Three or four years ago this canal claimed to have the best type of steamers in the country. It certainly is one well adapted to a trade where a heavy cargo is carried in one direction and no cargo is carried on the return trip. To make the boat run on an even keel when light the boiler is placed a little forward of amidships and the steam is carried in covered pipes to the engine in the stern. The engine acts directly on the propeller shaft, and is so arranged that it can be raised or lowered so as to throw the wheel, outside the boat, up or down, adapting its immersion to the loaded or light condition of the boat. The levers for controlling the steam and changing the immersion of the wheel are all within reach of the steersman, who is thus the engineer as well. A fireman is required to attend to the boilers and "bow" the boat through the locks. The propeller is a Neafie & Levy wheel. Such a steamer made the round trip from Cumberland to Georgetown and back, a distance of 369 miles, with 75 locks to pass each way, in 4 days and 20 hours, consuming from 4½ to 5 tons of coal. The machinery complete costs about $2,000. The canal has never been a very profitable investment for the state of Maryland or the stockholders so far as dividends on its traffic are concerned, but it has been of service to the public in bringing down coal and iron from the interior at low rates of freight.

In Virginia a canal extends from Richmond to Buchanan, on the James river. It is 196½ miles in length, and is 40 feet wide, with 4 feet depth of water. This canal was begun as a route for through traffic between the Ohio river and the sea-coast, but it is now virtually abandoned.

The Dismal Swamp caonal is about 30 miles long, but is not much used for canal-boats. Its importance is due to the fact that it is part of the long interior water route along the middle Atlantic coast, and allows of the passage of vessels through from Norfolk harbor to the sounds of North Carolina.

CHAPTER VII.—UNITED STATES NAVY-YARDS.

In a report upon the ship-building resources of the United States it seems appropriate to refer briefly to the establishments under the exclusive control of the government.

In the Revolution our fighting ships were built in private yards, and were mainly privateers for local owners, but included a few frigates for the government.

After the disbanding of the navy of the Revolution very few ships of war were required for a number of years, but in 1794 the necessity of protecting American commerce against pirates in the Mediterranean led to the construction of new vessels. The ships were built, as before, in private yards. The subject of establishing governmental navy-yards then came up, and was much discussed by public men; but no action was taken until 1801, when the President, on his own responsibility, bought sites for the establishments which were afterward created at Portsmouth, Boston, New York, Philadelphia, Washington, and Norfolk. Congress acceded to this action and appropriated the money to erect buildings and establish the plant for the construction, equipment, and repair of vessels. After that date for 60 years all the regular fighting ships of the United States were built by the government itself. The first achievement of the navy-yards was to send out a number of the frigates which gained so brilliant a fame in the war of 1812 and immortalized the navy of the United States. At the close of the war of 1812 naval stations were established at Whitehall, Sackett's Harbor, and Erie, on the northern lakes, and at Newport, Baltimore, Charleston, and New Orleans, on the coast, and the depredations by pirates in the West Indies led in 1821 to the location of a naval station at Key West and a navy-yard at Pensacola. A yard was established at Mare island, on the Napa river, in California, at a later date, and a naval station near New London, Connecticut.

No settled policy was ever followed by the government in building up the plant of its navy-yards. Expediency, and the sudden emergencies which have arisen from time to time, governed appropriations. Immense sums of money have been expended; nevertheless, nothing except the resources of the private ship-yards of the country has saved the national government from humiliation in naval operations in times of public peril. Incomplete as the navy-yards have been, however, they have been of great utility to the country. During their development in the years from 1812 to 1861 their ability to produce good ships was proved, and they reacted beneficially on the private ship-building interests of the country. There had grown up in them a race of constructors and engineers (in part recruited from the ranks of private life) whose investigations, experiments, and teachings were of vast service to the builders, outfitters, and owners of our merchant tonnage. In the years from 1860 to 1865 the government was suddenly called upon to improvise a navy, and the emergency was so great that 137 vessels were bought outright from the owners of ships, schooners, and steamers, 59 more being bought to load with stone and sink as obstructions to harbors. There also had to be built in 1861 14 screw sloops-of-war of 2,200 tons each, 23 gunboats of 500 tons each, a few western river gunboats, and a few iron-clads. The sloops were built mainly at the navy-yards, but the rest of the vessels could only be constructed at private yards. The contracts were given out all along the coast from Baltimore to Belfast, Maine. The 23 gunboats were built as follows: 1 at Baltimore; 1 at Wilmington; 3 at Philadelphia; 6 at New York; 1 each at East Haddam and Mystic river; 3 at Boston; 2 at Portland; and 1 each at Newburyport, Kennebunk, Bath, Thomaston, and Belfast; the cost varying from $52,000 to $56,500 for the hulls, and $31,500 to $47,500 for the machinery. From 10,000 to 12,000 men were employed in the four northern navy-yards at Philadelphia, New York, Boston, and Kittery, but even then the resources of the government were utterly inadequate to the emergency and the private ship-yards were the main dependence. The iron-clads and other armed vessels which were afterward built were made almost wholly by private establishments. From first to last in the four years of war the following ships of war were finished and sent into the service:

60 screw sloops, 845 guns in all, registering 116,303 tons.
47 paddle-wheel steamers, 452 guns, 44,532 tons.
23 gunboats, 123 guns, 11,661 tons.
11 tugs, propellers, 22 guns, 3,390 tons.
62 iron-clad monitors and steamers, 189 guns, 73,988 tons.

The navy-yards were much improved during the war, and did all the work of which they were capable. They proved to be valuable aids in building the sloops-of-war and in repairing the disabled and damaged vessels, but were overwhelmed by the demands upon them, and it was fortunate for the government that extensive private facilities existed. The material obtained regarding public yards is not complete, but it is such as could be gathered in the time allowed.

KITTERY, MAINE.

The establishment here is called the Portsmouth yard, as it is located across the harbor from the city of that name in New Hampshire. The equipment is all that is required for the building and repair of wooden vessels. The shops and buildings are now old and dilapidated, however. The sectional marine railway is one of the largest in the country, as two large ships can be repaired upon it at the same time. In this yard some of the sloops-of-war were built, and much valuable work was done from 1861 to 1865. Six large vessels are now laid up here in ordinary, and the Massachusetts, now useless, is on the stocks. The yard is at present occupied with an occasional task of rebuilding some old ship and repairing the government vessels which cruise on that part of the coast. Two or three wooden ships could be undertaken at once at this yard in case of need. There is at least 24 feet of water here at low tide.

BOSTON, MASSACHUSETTS.

At Charlestown, in Boston harbor, the government has about $10,000,000 invested in grounds, shops, machinery, and general ship-yard plant. In ordinarily busy years about 500 men are employed in building and repair work and in the manufacture of ordnance stores, cordage, blocks, iron work, boilers, and whatever happens to be required for the maintenance of ships of war. The sum of $383,000 was expended for labor in the yard in 1879-'80, and the further sum of $1,597,000 for materials. In this yard all the hemp and wire rope used in the navy is manufactured. The following statement has been prepared by Commodore Badger:

UNITED STATES NAVY-YARD,
Boston, Massachusetts, September 19, 1882.

The Census Agent on Ship-building, Department of the Interior, Washington, D. C.

SIR: In compliance with your request, I hereby forward the required data for the completion of your report on the capacity of the navy-yard under my command relative to the building and repairing of ships of all kinds.

The various shops in this navy-yard are all in good condition, and are as follows:

1. *The principal machine-shop.*—This is among the largest and best fitted in the country, and is capable of doing the work necessary for iron- or steel-ship building. It contains all the most improved tools and machinery, and is two stories high, the upper floor being used for light work.
2. *A smaller machine-shop.*—Especially adapted for separate light work in iron and steel.
3. *Boiler-shop.*—Fitted with machinery and tools for building stationary, portable, and heavy marine boilers.
4. *Heavy forge-shop.*—Especially fitted for rolling iron from scraps and making heavy forgings.
5. *Two iron and brass founderies.*—Fitted for heavy and light work, all the machinery and tools in prime order.
6. *Smithery.*—For engine forgings and other work.
7. *Two copper-shops.*—One for making copper and brasses for heavy marine engines, while the other is fitted for lighter work.
8. *Pattern-shop.*—For making patterns for any size of marine engines. In these shops, that is, the pattern-shop, machine-shop, etc., a number of large engines have been made and numerous extensive repairs conducted on others.
9. *Rope-walk.*—The best in this country, and contains all the newest machinery for making rope of hemp, manila, hide, or wire.
10. *Sail-loft.*—Very large, and equal to every emergency.
11. *Boat-shop*, which has always been capable of carrying on its proportion of the work.
12. *Mold-loft.*—With all necessary tools and machinery for work under that head.
13. *Spar-shed.*—Of sufficient size and capability, with a large number of mast spars on hand.
14. *Saw-mill.*—With bevel and other saws, the best of any at our navy-yards, and capable of doing, with its machinery, all the necessary work to carry on wooden-ship building.
15. *Block-shop and rigging-lofts.*—Both of sufficient size and equal to any demands.
16. *Joiner-shop.*—Most complete, with all the machinery and room necessary.
17. *Plumber-, tin-, and small cooper-shop*, also *paint-shop*, each of which is capable of performing the work coming under its head.

For convenience of carrying on work all the shops enumerated from 1 to 8, inclusive, are close together; and there is sufficient steam-power at hand to carry on the most extensive business, three of the engines having 100 horse-power each. There are, besides, provision and other store-houses in the yard for stowage of ship materials, all well supplied, and two wet-timber docks for seasoning purposes.

As to docks, slips, and sheds for the building and repair of ships, there is but one dry-dock, built of granite at a total cost of $993,915. This dock is capable of receiving any ship not over 379 feet long, 60 feet beam, or 27 feet draught of water. There are three ship-houses with building-ways and three building-slips, making in all six sites for the building of ships. Four of these sites are at present occupied by old-style ships, which will not be completed. With all of the ways clear six vessels might be built at this yard at one time, all the ways being now in good condition.

For constructing the largest iron or steel ships sheds adjacent to the ship-houses could with ease be erected in six weeks, at a cost of not more than $30,000, containing furnaces for heating plates and all the necessary appliances for completing the work.

There were during the late war about 5,000 men employed to advantage in this navy-yard, and this I consider as many as would be necessary to work the yard to its full capacity.

Since its establishment in 1800 there have been launched at this yard 39 ships-of-war, of which the most important or conspicuous were:

The Independence, ship-of-the-line, launched in 1814.
The Marion, sloop-of-war, launched in 1839.
The Bainbridge, brig, launched in 1842.
The Cumberland, frigate, launched in 1842.
The Plymouth, sloop, launched in 1843.
The Vermont, ship-of-the-line, launched in 1848.

The Princeton, frigate, launched in 1851.
The Merrimac, frigate, launched in 1855.
The Hartford, frigate, launched in 1858.
The Monadnock, double-turret monitor, launched in 1864.
The Guerriere, frigate, launched in 1865.
The Worcester, frigate, launched in 1866.
The Alaska, sloop-of-war, launched in 1868.
The Intrepid, iron torpedo-boat, launched in 1874.
The Vandalia, sloop-of-war, launched in 1874.

Several vessels were also built for the Treasury Department at this yard for duty in the light-house service, coast survey, and revenue marine, and most extensive repairs have been made to vessels of all classes.

I am, respectfully,

O. C. BADGER,
Commodore United States navy, commanding United States navy-yard, Boston, Massachusetts.

Captain C. C. Carpenter, equipment officer, reports the following materials used in outfits in the year ending June 30, 1880:

Pounds of iron and steel	891
Pounds of hemp rope	21,619
Pounds of manila rope	41,023
Pounds of hemp rope shipped to other stations	186,882
Pounds of manila rope shipped to other stations	297,086
Yards cotton canvas used for sails	9,570
Yards flax canvas used for sails	8,881

It is in this yard that some experiments have been made with a machine for bending the oaken frame timbers of ships so as to make them in one piece from keel to gunwale. The machine cost $160,000, and bent a large number of knees and timbers in a satisfactory manner. The yard is much resorted to for tests of the strength of timber growing in different parts of the United States. This establishment is highly valued by officers of the navy, as its location is an excellent one. The water is deep, the approaches are capable of defense from attack, and the harbor is easy of access but difficult to blockade. No embarrassment is likely to arise on account of ice, and the proximity of the ship-yards, engine-shops, and general mechanical facilities of the city of Boston adds materially to its resources.

NEW LONDON, CONNECTICUT.

The yard at this point is located on the eastern bank of the Thames river. It enjoys deep water and a fine climate, and was established in 1868. The grounds have been graded and a large building erected, but at present the place is mainly a depot for the laying up of old navy vessels.

BROOKLYN, NEW YORK.

This is the most important of the navy-yards. There are 245 acres within the inclosure, and the plant represents an investment of about $15,000,000. Located on the water-front of Brooklyn opposite the heart of the city, and directly across the East river from the business portion of New York, the land alone which it covers is estimated as worth $25,000,000. Its equipment is complete, and the important iron works and engine-shops in the great communities bordering on the East river can be depended upon for assistance in fitting out navy vessels when required. The New York shops made the best and cheapest machinery that was built during the war. There are laid up at this yard a number of old war ships, some of them of the type of frigates of 60 years ago. On the stocks are 3 wooden vessels in frame, the Java, the New York, and the Colossus, which have been there since the close of the late war, and of which the New York alone is said to be worth finishing. The yard has done little or no building of late years, but repairing and outfitting are carried on to a considerable extent, and experiments and investigations of various kinds are continually undertaken. The aid to the commodore commanding the yard has prepared the following data for this report:

NAVY-YARD, NEW YORK, *November* 24, 1882.

The Census Agent on Ship-building, New York City.

SIR: In reply to your request, I take pleasure in furnishing the following information:

The yard comprises some 245 acres, with a water-front of nearly $2\frac{1}{4}$ miles. In addition to the shops and appliances for the construction, repair, and outfit of ships, the yard contains a complete naval hospital, a laboratory, extensive marine barracks, and receiving quarters for 6,000 men. The sewer which empties much of Brooklyn's refuse into the Wallabout bay and constantly shoals the water-way is about to be removed, an appropriation for that purpose having been made by the last Congress. Among the buildings are:

1 iron-plating shop.
1 smithery.
1 steam-engine machine-shop.
1 ordnance machine-shop.
1 boiler-maker shop.
1 plumber-shop.
1 cooper-shop.
1 joiner-shop.
1 block-shop.
1 foundery.
1 shipwright's shop.
1 saw-mill.
1 oakum mill, with drying platform.
1 wheelwright's shop.

3 buildings for the reception, preparation, and distribution of provisions and clothing, all fitted with boilers and machinery for their respective purposes.
1 mold-loft.
1 sail-loft.
1 rigging-loft.
1 yards and docks storehouse.
1 steam-engineering receiving storehouse and offices.
1 ordnance and navigation storehouse and offices.
1 chain-cable storehouse.
1 construction storehouse and offices.
1 equipment storehouse and offices.
2 steam iron derricks.
1 steam floating derrick.
1 tar shed.
6 timber sheds.
2 cart sheds.
7 sheds for general purposes.
1 spar shed.
1 boatbuilder's shed.
1 gun-carriage shed.
1 tank shed.
1 shipwright's shed.
1 foundery shed.
2 ship-houses.
2 pitch-houses.
1 gate-house.
7 officers' houses.
2 coal-houses.
2 guard-houses.
1 lyceum and offices.
1 civil engineer's office.
2 reservoir houses.
1 engine-house (steam-fire).
2 music-stands.
1 chapel.
2 oil and paint-shops.

ON ORDNANCE DOCK.

1 gunner's house.
1 howitzer shed.
4 shell, shot, etc., houses.
1 ordnance storehouse.
1 boiler-house.

HOSPITAL GROUNDS.

1 hospital.
1 laboratory.
1 chapel.
2 officers' houses.
2 stables.
2 boiler-houses.
1 coal-house.
1 gate-house.
1 cart shed.

MARINE BARRACKS.

1 marine barrack.
1 commandant of marines' house.
1 general quarters for marine officers.
1 gate-house.
1 boiler-house, with sheds.

There is one stone dry-dock, with boiler and attached engine. There are no marine railways, but there are slips already built where railways could be readily added.

Iron ships can be built. There is no other yard in the country that could be so easily prepared for the demands of present iron ships. With the addition to the present plant of a furnace for the bending of angle-iron any iron ship could be constructed to meet the present demands.

More than sixty ships of war have been built at this yard, including the following:

President (frigate).	Medina.	Maumee.	Mercury.
Erie (sloop-of-war).	Albany.	Shamrock.	Quinnebaug.
Savannah (44-gun ship).	San Jacinto.	Mackinaw.	Shawmut.
Sabine (44-gun ship).	Dolphin.	Peoria.	Severn.
Vincennes.	Iroquois.	Tallahassee.	Java.
Peacock.	Oneida.	Algonquin.	New York.
Enterprise.	Adirondack.	Colossus (iron-clad monitor).	Plymouth.
Relief.	Octarora.	Florida.	Swatara.
Fulton.	Miantonomoh (iron-clad monitor).	Tennessee.	Alarm (iron torpedo-boat).
Levant.	Ticonderoga.	Nyack.	Trenton.
Missouri.	Lackawanna.		

The highest number of ships building at one time was seven. In an emergency, with the present condition of the water-front, ten ships could easily be built at once, and with projected extension and deepening twice that number.

Over 7,000 men have been employed at the same time in this yard, 4,000 of them in the construction department alone. The number of men that could be employed would depend entirely upon the appropriation Congress might give, the possibilities of the yard exceeding any possible appropriation.

Very truly, yours,

W. H. JAQUES,
Lieutenant United States Navy.

The land occupied by this yard is in demand for commercial purposes; but the location is one of the best in the United States, and it so nearly fulfills all the conditions of a good site for a navy-yard that the officers of the navy do not advise its sale. With the completion of proper forts at the entrances to the harbor and around the city of Brooklyn the yard could not be captured. The water is deep, the plant is in excellent condition, and the lines of communication with the interior are held to be of the highest value. The chief drawbacks here are the floating ice in the river, occasional fogs, and the lack of proper facilities at the yard for docking vessels.

PHILADELPHIA, PENNSYLVANIA.

The League Island yard, in the lower edge of the city of Philadelphia, is of recent date. The old yard was farther up the Delaware and nearer the heart of the city, but it was too small, and was removed to the island in 1868. The equipment is not yet complete. Repair work occupies the men employed here chiefly, and is all work on the topsides and top-gear and on the inside of vessels, because the facilities do not yet exist for taking the ships out of water. For calking and coppering recourse is had either to the private docks in Philadelphia or to the navy-yard at New York. A number of iron vessels are laid up at the island awaiting repairs or completion. It will require several years of dredging and filling in before there is enough solid ground at this yard for the necessary accommodation of the establishment. The following official data have been obtained from Commodore Simpson, commandant of the yard:

NAVAL CONSTRUCTOR'S OFFICE,
UNITED STATES NAVY-YARD, LEAGUE ISLAND, PENNSYLVANIA,
September 21, 1882.

SIR: Referring to the communication from the census agent on ship-building, dated 16th instant, requesting information relative to the facilities of this yard, I have to state that there is no plant for iron-ship building, no building-shop for building a ship of either wood or iron, no dry-dock or railway, and no derricks or other means of raising heavy weights by steam-power.

The shops devoted to the repair of vessels consist of two-machine-shops, a smithery, spar shed, boat- and block-shop, paint-shop, saw-mill, mold-loft, and brass foundery, together with accommodations for plumbers, etc. There is no iron foundery or furnaces for heavy forging.

The shops are amply provided with steam-power, and the tools are sufficient for repairing two or three vessels at one time; but the machinery for a ship of large size could not be manufactured here at present, owing to the lack of tools sufficiently powerful, such as trip-hammers, boring-mills, etc.

From 800 to 1,000 workmen can be employed with the present facilities.

No vessels have been entirely constructed here, though the Juniata was quite extensively repaired.

Very respectfully, your obedient servant,

F. L. FERNALD,
Naval Constructor, United States Navy.

Commodore EDWARD SIMPSON, U. S. N.,
Commandant Navy-Yard, League Island, Pennsylvania

WASHINGTON, DISTRICT OF COLUMBIA.

The yard at Washington is an important one, and though covering 42 acres of ground is crowded with buildings. The establishment is one of the first class. It is embarrassed at times by the shoaling of the water in the eastern branch of the Potomac, arising from the wash of earth from the neighboring hills, but the trouble is easily corrected by dredging. The following data have been obtained through the agency of Commodore Pattison, commandant at the yard, from Chief Engineer Henderson, Commander Howell, Commander Casey, Chief Engineer Menocal, Constructor Pook, and Master Carpenter Collins:

STATEMENT OF THE AREA, BUILDINGS, EQUIPMENTS, EMPLOYÉS, WATER-FRONT, ETC., OF THE UNITED STATES NAVY-YARD AT WASHINGTON, DISTRICT OF COLUMBIA, OCTOBER 1, 1882.

The yard covers 42 acres of ground, and is filled with the shops and storehouses necessary for building, fitting, and repairing the largest vessels. It is capable of employing 4,000 men upon such work. The water-front is 1,250 feet in length. The shops cover an area of 261,246 square feet, and the storehouses 49,281 square feet. The following is a description of the different shops, ship-houses, etc., with their equipments, and the number of employés in each:

DEPARTMENT OF CONSTRUCTION AND REPAIR.

Brass foundery and finishing shop.—Area, 5,418 square feet. Employment for 60 men. Contains 1 furnace, 1 drying oven, 3 brass furnaces, 4 cranes, 22 lathes, 4 planers, 4 drill-presses, 1 boring-machine.

Blacksmith and coppersmith shop.—Area, 4,535 square feet. Employment for 60 men. The first contains 14 forges and 1 steam-hammer; the second 3 forges and complete outfit for all coppersmiths' work.

Copper-rolling mill.—Area, 24,047 square feet. Employment for 43 men. Fitted with 5 nail-machines, 4 sets sheet-rolls, 1 set rough rolls, 1 set finishing rolls, 6 furnaces, 3 shears. The daily capacity of the mill is 2,500 pounds sheathing and 3,000 pounds bolts.

East saw-mill.—Employment for 10 men. Contains 1 circular saw, 1 futtock saw, 1 bench saw, and 1 planer. It is situated in the ship-house, covering the marine railway.

West saw-mill.—Area, 15,978 square feet. Employment for 10 men. Contains 1 sash saw, 1 futtock-mill, and 1 spindle-planer.

Mold-loft.—Area, 11,820 square feet, over timber shed. Employment for 10 men. The largest vessels can be laid down. A draughting-room is attached.

Ship-house.—Area, 18,672 square feet. It is 306 feet long, and a first-class frigate can be built in it.

Marine railway.—Length of track, 495 feet, width 20 feet; can take a vessel of 52 feet beam. There is a hydraulic pump with 2 engines of 25 horse-power each for raising and lowering the cradle.

Joiners' shop.—Area, 10,111 square feet. Employment for 75 men. It contains 2 planers, 3 lathes, 1 band, 1 gig and 1 circular saw, 1 saw gummer, 1 molding-machine, 1 grating cutter, 1 mortising and 1 tenoning machine, 1 gouging-machine, 1 boring-machine, and 1 drill press.

Boat shed, employing 18 men.

Paint-shop, employing 75 men.

Calkers' shop, employing 150 men.

Iron-platers' shop, small and incomplete.

Besides the two engines for the marine railway there are two in the rolling-mill of $1\frac{1}{2}$ horse-power each, one of 40 horse-power in the iron-platers' shop, 1 of 60 horse-power in the east saw-mill, and 1 in the joiners' shop and west saw-mill.

Five vessels could be built at one time, employing 1,000 men, and about 20 vessels could lie at the wharves for repairs. This department could thus employ 1,800 men.

There is no plant for building iron vessels.

DEPARTMENT OF STEAM ENGINEERING.

Machine- and erecting-shop.—Area, 52,749 square feet. Employment for 620 men, including an outside gang of 200 men employed on board the ships. There are the following tools in these shops, viz: 32 vises, 17 planers, largest $36\frac{1}{2}$ by 20 by 20 feet, 15 shaping machines, largest $7\frac{1}{2}$ by $1\frac{1}{2}$ by $4\frac{2}{3}$ feet, 61 lathes, 7 boring machines, largest 100 inches by 20 feet, 9 slotting-machines, 20 drill-presses, 2 facing-machines, 5 screw-cutting machines, 20 other machines (various), 7 wood and 6 iron cranes.

Boiler-shop.—Area, 12,720 square feet. Employment for 250 men. It contains the following: 2 riveting machines, largest can rivet to center of 13-foot plate, 1 set plate rolls, 2 trip hammers, 1 punching and shearing and 6 punching machines, 2 shears, 4 iron cranes.

Foundery for iron and brass.—Area, 14,904 square feet. Employment for 100 men. Contains 4 cupolas, 2 of 30 tons, 1 of 12 and 1 of 5 tons, 4 blowers, 2 reverberatory furnaces, 1 for iron, of 15 tons capacity, and 1 for brass, of 4 tons, 12 brass furnaces, of 200 pounds capacity, 4 iron and 5 wooden cranes.

Pattern-shop.—Over machine-shop. Employment for 30 men. Area, 20,000 square feet. Contains 12 benches, 2 circular, 2 gig, and 1 band saw, 4 lathes, 3 face lathes, 3 planers, 3 molding-machines, 1 rod machine, 1 boring and 1 mortising-machine.

Two steam-engines are employed, one a Corliss engine, the other a vertical engine built in the yard.

Total area of shops is 100,373 square feet, and the total number of employés 1,000.

The shops of this department are the largest in the yard and the most complete in their outfit. The machinery is large, and the most powerful engines and largest boilers can be constructed. The machine-shop is second to none in the United States, either public or private.

DEPARTMENT OF YARDS AND DOCKS.

In addition to the plant already referred to are the following: 2 iron cranes, one of 15 tons and the other of 20 tons; 1 masting shears of 65 tons; 1 platform scales of 10 tons.

Complete system of gas throughout the yard, buildings, etc.

Car-tracks connecting all the principal shops with wharves, cranes, scales, etc.

Store-houses and buildings for the care and protection of all public property.

DEPARTMENT OF ORDNANCE AND GUNNERY.

Brass foundery and blacksmith-shop.—Area, 6,251 square feet. Employment for 50 men. They contain the following, viz: 1 cupola of 10 tons capacity; 6 brass furnaces of 200 pounds; 4 reverberatory furnaces for bronze, capacity of each 10,000 pounds; 1 wooden crane and 1 blower; 2 forges.

Machine-shop.—Area 16,551 square feet. Employment for 425 men. It contains 69 lathes, largest swings 4 feet $3\frac{1}{2}$ inches and 56 feet 7 inches long; 7 planers, largest 21 by 7 feet; 2 slotting-machines; 5 shaping-machines; 1 machine for boring the trunnion bearings of gun-carriages; 4 drill-presses; 1 large testing-machine for metals, limit 100,000 pounds per square inch; 2 round-ball turning-machines.

Pattern-shop.—Area, 5,484 square feet. Employment for 20 men. Contains 1 band, 1 scroll, and 1 circular saw; 3 planers; 1 spoke planer; 1 boring-machine; 5 lathes; 9 benches.

Shell-house.—Area, 7,847 square feet. Employment for 150 men. Has a complete outfit for strapping shells, fitting gun-gear, etc., with a large storage capacity for shells and gear.

Laboratory.—Area, 4,420 square feet.

A new gun foundery has been built, covering 19,185 square feet, but never fitted.

There are two steam engines attached to this department, one for the machine-shop and a small one for the pattern-shop.

Total area of shops, 59,738 square feet, with employment for 645 men.

EQUIPMENT DEPARTMENT.

Forge-shop, anchor-shop, iron-rolling mill, and fagoting-shop.—These shops are all in the same building, covering an area of 35,268 square feet, and can employ about 90 men. The forge-shop contains 3 furnaces, one capable of heating 8 tons, and two with capacity of 5 tons each; 1 large steam-hammer, weight 16,500 pounds; 4 wooden cranes, and 1 forge for heavy work. The anchor-shop contains 4 forges for heavy work and 3 furnaces for light work; 2 Dudgeon steam-hammers, one with a cylinder of 16 inches and one with a cylinder of 20 inches diameter. The rolling-mill contains 1 train of rolls 19 inches in diameter for 4 to $\frac{1}{4}$-inch round iron, angle, square, and flat iron, trim to 4 feet in width by 14 feet length, and $\frac{3}{8}$ inch thick; 1 proof-shears. The fagoting shop contains 3 scrap furnaces, capable of heating 1,600 pounds each; 2 Dudgeon steam-hammers, diameter of cylinders, 12 inches. These shops are fitted with 1 engine of 78 horse-power, 1 engine of 60 horse-power, and 1 engine of 18 horse-power, 2 blowers, 10 large wooden cranes, and 1 small iron crane.

Blacksmith-shop, chain-cable shop, and galley-shop.—These shops are in the same building with those of department of steam engineering. They cover an area of 20,753 square feet, and employ 220 men. The blacksmith- and chain-cable shop contains 40 forges, 1 steam-hammer of $3\frac{1}{2}$ tons, 1 chain-proving machine, 1 furnace, 2 link-benders, 1 large fan (used also by department of steam engineering), 6 iron cranes. In attached machine-shop are 1 lathe, 2 drill-presses, and 4 vises. The galley-shop contains 2 lathes, 4 drill-presses, 1 planer, 1 shaper, 1 bolt-cutter, 20 vises, 1 outfit of tinner and coppersmith tools, 5 forges, 3 wooden cranes, 1 iron crane, 1 small steam-hammer, and one combined punch and shears. In attached pattern-shop are 1 small lathe and 2 benches.

Rigging-loft (over iron store).—Employs 50 men, and is fitted complete for rigging largest vessels.

Sail-loft (over timber shed).—Employs 35 men, and is fitted for all canvas work for fitting first-class frigates. The buildings of this department cover 56,021 square feet, and employ 395 men.

This department is supplied with the necessary implements, etc., for making anchors, chains, and galleys for the entire navy.

MEMORANDA OF VESSELS BUILT AT THE NAVY-YARD, WASHINGTON, D. C.

Name.	Class.	Tonnage.	Date of building.
		Old measure.	
Columbus	Line-of-battle ship	2,480	1819
Potomac	First-class frigate	1,726	1821
Brandywine	......do	1,726	1825
Saint Louis	Second-class sloop	700	1828
Columbia	First-class frigate	1,726	1836
Saint Mary's	First-class sloop	958	1844
Water Witch 1	Side-wheel steamer		1844
Water Witch 3	......do		1846
Water Witch 4	......do		1852
		New measure.	
Minnesota	Steam frigate	3,000	1854
Nipsic	Steam sloop	615	1874

MEMORANDA OF STEAM MACHINERY BUILT IN THE ENGINEERING DEPARTMENT OF THE UNITED STATES NAVY-YARD, WASHINGTON, DISTRICT OF COLUMBIA.

Names of vessels.	When built.	Description of engines.	Displacement, in tons.	Indicated horse-power.	Cylinders. No.	Cylinders. Diameter.	Stroke.
						Inches.	*Inches.*
Water Witch	1852	Inclined	578	180	1	37½	72
Union	1846	Horizontal, vertical shaft		400	2	40	48
Hancock	1853	Vertical, oscillating		80	2	20	21
Minnesota	1854	Horizontal trunk	4,700	1,200	2	79½	36
Swatara	1863	Horizontal, back-acting	900	600	2	36	30
Resaca	1863	......do	900	600	2	36	36
Naval Academy	1863	......do		600	2	36	36
Saco	1863	......do	900	450	2	27	30
Richmond	1863	......do	2,700	1,400	2	60	36
Bon-Homme Richard	1865	Horizontal, direct-acting		4,400	2	100	48
Epervier	1867	Horizontal, back-acting		600	2	36	48
Swatara	1872	Horizontal, compound back-acting	1,900	1,200	2	42 and 64	42
Quinnebaug	1872	......do	1,900	1,200	2	42 and 64	42
Marion	1872	......do	1,900	1,200	2	42 and 64	42
Vandalia	1872	......do	2,200	1,200	2	42 and 64	42
Galena	1874	......do	1,900	1,200	2	42 and 64	42
Mohican	1875	......do	1,900	1,200	2	42 and 64	42
Steam cutters, first class	About 100 to date	Vertical, direct-acting	8	25	1	8	8 and 10
Steam cutters, second class	About 100 to date	Vertical, direct-acting	5	15	1	6	6

NORFOLK, VIRGINIA.

This yard is one of the most conveniently situated on the coast for the building and repairing of vessels, and is much employed by the department for that purpose. Many of our ships of war have been rebuilt here. The yard was of great service to the confederate navy after 1861, although much of the property it contained was destroyed by fire. Several wooden vessels could be undertaken at once here, and the situation is the most favorable in the country for obtaining cheap white oak of the best quality. The yard is deficient in plant for iron-ship building, but the shops and tools exist for making engines and boilers of the largest class. One of the strong points of the location is that the harbor is never obstructed by ice, and the mildness of the climate, the ease of access to the harbor, and the ample anchorage for a large fleet make the place the most valuable rendezvous for war vessels on the whole Atlantic coast.

PENSACOLA, FLORIDA.

The navy-yard at Pensacola is the only one on the Gulf, and on that account it is an important station. The lack of proper facilities prevents any work being done at present, except in the way of repairing tugs and small vessels. Before the war the yard was well equipped, and the department is now making every effort to have it restored to its former condition. A large dry-dock is in process of construction, a timber shed has recently been built, and machinery is also being bought. The yard was formerly in good condition, but at the close of the war of 1861 it was in a state of complete dilapidation. So far as the construction of wooden vessels is concerned Pensacola is favorably situated, live oak and yellow pine of the best quality growing in abundance in the surrounding country.

MARE ISLAND, CALIFORNIA.

This is a large and important yard, the only one on the Pacific coast, and is situated on an island at the junction of the Napa river with the Sacramento opposite Vallejo. Appropriations for its equipment have been liberal. The grounds are large, the buildings are numerous and strong, and the machinery equipment is already extensive. A floating dry-dock is employed for examining the bottoms of vessels, but a large stone dry-dock is being built to take its place. It has long been considered desirable to create the means here for building iron vessels, and steps have been taken with that object in view, an iron-plating shop having recently been completed. The wooden war-ship Mohican, propeller, is in frame on the stocks, and is covered with a shed. The yellow fir of the Oregon region has been used in its timbers, and the ship is considered by the department as worth completion. One of the four unfinished iron monitors of the government, the Monadnock, lies upon the stocks at Vallejo, opposite and below the navy-yard. Like its sisters, the Terror at Philadelphia, the Puritan at Chester, and the Amphitrite at Wilmington, it is awaiting the appropriation necessary to put it in launching condition. This yard is held to possess many great advantages. The depth of water is from 24 to 26 feet, which is ample for any war ship of the present day, and the fresh water of the Napa river preserves the hulls of wooden vessels laid up here from the attacks of the teredo. There is an abundant supply of good timber, which can be brought down by interior routes from the north. The climate is mild, the yard almost inaccessible to attack, and the present value of the buildings is over $4,000,000.

CHAPTER VIII.—SHIP-BUILDING TIMBER.

At the time of the settlement of her American colonies the forests of England had begun to be severely taxed for a supply of good ship-building timber. During the early part of the seventeenth century the British navy had increased rapidly in importance, and the trade to the East Indies and other distant parts of the world was leading to the production of an immense number of ships. Not only was the consumption of oak for the building of new vessels large, but the warfare continually waged by England upon the sea required the incessant repair of ships and made a demand upon the oak forests of the country for that purpose almost as large as for the building of new vessels. The cultivation of young timber was totally neglected in England, and as the local consumption was large and the forest area small the supply of navy timber grew continually less. As early as 1660 naval officers had already become apprehensive that there would soon be a deficiency of oak timber in England. The price of the wood had nearly doubled in fifty years. The contract price paid for straight timber about 1663 varied from £2 to £2 15*s*. per load of 50 cubic feet, and for knee timber the prices varied from £2 15*s*. to £3 3*s*. per load.

The scarcity of proper timber for the construction of the best class of vessels was a serious matter to a country whose safety in defense depended almost entirely on the possession of a strong navy, and the Fellows of the Royal Society were appealed to for suggestions as to the proper manner to increase the timber supply. The subject was taken up by Mr. Evelyn, one of the Fellows, who recommended "that a universal plantation of all sorts of trees should be encouraged, as the only way of insuring a sufficient supply in the future". Mr. Evelyn agitated the subject of the growing deficiency of timber for forty years, and the facts he presented to the British public so alarmed them that timber trees were planted on private property in almost every part of England, especially in the royal forests, England having in this matter heeded the profitable example of Portugal.

Oak trees large enough for the construction of vessels of considerable size are from 100 to 250 years old, so that these young plantations were not available for several generations after the time of Evelyn. The trees became large enough to cut about the time of the American revolution. A report made by Lord Melville in 1810 states "that the vast quantities of great timber consumed by our navy during the present reign were chiefly the produce of the plantations made between the Restoration and the end of the 17th century".

A fresh demand was made upon the timber resources of England shortly after the Restoration by the celebrated "navigation act", which compelled Englishmen to employ British built vessels only, and a still greater demand sprang up after the independence of the American colonies, from the fact that English merchants could then no longer own a vessel built in the colonies, and had to build their vessels at home. The destruction of British oak increased largely, therefore, year by year, reaching in 1811 about 260,000 loads annually, and although the quantity of timber required diminished somewhat after that date, owing to the fewer losses of ships by war, yet the timber supply continued to decrease also and the price of oak rose steadily. During the war of 1812 English oak brought £7 5*s*. per load, and for thirty years after that it still brought an average of about £6 per load. From the necessities of the case England soon became obliged to rely on foreign countries for a large part of the ship timber she required. The first importations were of white oak from the Canadian provinces; a further quantity was imported directly from America; in fact, every country in the world producing timber of any value was resorted to by the English builders. Many vessels were built after the war of 1812 out of European larch, and a great many others were built out of fir from the Baltic. Pitch-pine was also imported from the United States, and other kinds of timber were brought from the cape of Good Hope and from the East Indies.

After the war of 1812 there were several periods of great stagnation in the maritime enterprise of England. Several investigations into the causes were ordered by parliament, and in 1833 and 1847 the subject was inquired into exhaustively. One of the principal topics discussed by the parliamentary committees on all these occasions was the high price of ship timber and its effect upon the cost of English-built ships. It was shown that vessels built in London cost £28 per ton, and those on the other coasts of the country from £15 to £18 per ton, while vessels built on the Baltic could be constructed for £8 to £10 per ton, the cost in America being from £10 to £12. These differences were almost entirely due to varying cost and abundance of timber. The most serious feature of the high prices and scarcity in England was the fact that the causes were such that there was no room for hope for the future. With the increase in population and progress in refinement the general consumption of timber in the useful arts and the heating of houses had been increasing. More wood was required annually than could be produced by the natural growth of the forests. The high price of food had rendered the land valuable for cultivation, the fields had been cleared and plowed, and there had been an utter neglect of the planting of young trees on land that could not be tilled. Besides that, under the protecting legislation of England, the requirements of the merchant navy were constantly increasing, and the manner in which estates are owned in England soon interposed an obstacle to the cutting of timber even where forests still existed. At the time that the building of iron vessels became an industry the English oak was virtually all gone, and the difference in cost between the ship built of timber and the one built of iron was hardly worthy of mention. The invention of the iron ship was the salvation of the naval art in England, and probably of her merchant marine.

As the English forests were already giving out when colonies began to be planted in the New World, it will be seen that the emigrants enjoyed a decided advantage over their brethren at home in the manufacture of ships—an advantage improved, however, substantially only for the local needs of the colonists themselves. The multiplication of vessels in the colonies during the early part of their history was remarkable.

The country was covered with large, tall trees, suitable for ship-building, and the excellence of the timber was repeatedly mentioned in the reports and narratives of the early discoverers. Foremost were the white-oak trees, growing in dense and almost continuous forests along the whole north Atlantic coast and extending in a scattered way down even into the heart of the yellow-pine region in Georgia. The trees existed in enormous supply, generally had straight trunks, though yielding a great deal of crooked timber, grew from 60 to 80 feet in height, and averaged 3½ to 4 feet in diameter at a man's height from the ground, while sometimes found as large as 8 feet in diameter. Tough, strong, elastic, and, if cut in the right season of the year, durable, this valuable timber has proved the mainstay of American ship-building from the earliest days to the present time. It is especially suited for the frames and vertebral pieces of vessels, and in spite of its weight is the best wood for the planking of the vessels of every size. Such as grows near the sea-coast and in the swamps is remarkably free from defects of every kind, and so abundant was the timber once that early builders used nothing except the heart of oak in their vessels, sawing off the outer or sap-wood and selecting nothing except the durable inner portion. The fastidiousness of the builders led to an unnecessary destruction of the tree, for of timber thus handled at least one-half becomes waste. So cheap was American oak that vessels built of it for the first hundred years cost only about one-half the price of oak vessels in Europe. It was at first supposed that no timber should be put into a vessel's frame except that which had a natural curvature, and when the crooked timber had been culled from the forests there was some doubt whether its place could be supplied. A practice soon became general, however, of hewing the frames out of straight timber; a practice due to necessity, but found to answer nearly as well. The discovery led again to a great destruction of timber. It is estimated that frames cut from the log or from flitch waste at least one-third and often one-half of the original tree.

The causes which led to the disappearance of the oak in England also came into operation here, and within the recollection of persons now living the white oak has almost entirely disappeared as a ship-building timber in the states in which that industry has been the most actively carried on. In Maine virtually all of the oak accessible from the coast is gone, and only a few small and scattered bodies of it now exist. It is thought that in the western part of the state, in the vicinity of Wells, there is oak enough still left to supply the frames of about 200 vessels; but it grows largely on property where it is valued for its effect in the landscape, and cannot be utilized commercially. The white oak was not indigenous to the valley of the Kennebec to the north of Waterville, nor on the Penobscot north of Bangor, but it did grow inland as far as those points. Many of the more inland bodies of it were not reached for many years; but the construction of railroads finally brought them all into market, and the urgent demand for timber has led to their destruction. There are oak trees of the red and other species (very good timber) found in the mountainous and broken parts of Maine; but they are not at present accessible, nor do they exist in quantities sufficiently large to add materially to the resources of that state for ship-building timber. Owing to the great scarcity of oak on the coast people have lately been compelled to use trees of second growth and all the poorer varieties which, fifty years ago, no Maine man would have introduced into his vessel. It is not to be supposed that the gradual wasting of the forest wealth of Maine has been allowed to go on without remonstrance from the state government. In 1868 the board of agriculture of that state aroused the attention of the landholders to what was going on, the facts coming to many minds with the force of a new revelation; and in consequence of the alarm then existing the people of Maine began to cherish their forest trees as never before. It is believed at Augusta that in the older and better settled portion of the state the amount of growing wood and timber is now suffering no material diminution, and it is thought by some that the area in the state devoted to forestry is now larger than it was twenty years ago. It is to be borne in mind, however, that this is chiefly due to the fact that ship-builders have been driven to other states for the material for their vessels, especially for those of a large class, and having found in the southern states a sufficient and cheap supply, they have for the last twenty years been importing into the state all the timber they needed. This circumstance is giving the forests of the state a chance to rest and recuperate; meanwhile, the state is left without a local supply of oak, and is entirely dependent on the resources of other parts of the coast.

The southern part of New Hampshire was once densely covered with oak, and the Portsmouth vessels were always constructed from local timber. Both on account of the excellence of the wood and the good workmanship of the builders there was a time when New Hampshire vessels got the best rates of insurance in the country, but all of the timber within easy distance of the coast has now disappeared. The northern part of the state is stocked with red oak, intermingled with other timber, and when railroads are built in sufficient number to cover that region a great deal of timber will come into market; but there is no prospect at present of this being done in time to benefit the decaying ship-building industry of the state.

In Vermont white oak is still in fair supply, and is scattered over a large part of the state, more especially in the counties bordering on lake Champlain. The woods have been much culled near the rivers and lakes, but what is left is small and of good quality. Vermont has enough oak for her own limited use for a long time, with some to spare. Owing to the lack of cheap transportation much of it will not be called for until the supply elsewhere becomes so reduced that the increased price will pay the cost of hauling long distances, and by that time the supply will probably be much lessened by local consumption.

In Massachusetts nearly all the oak is gone. It is stated that, while a certain amount is still to be found in the state, much of it is preserved as a feature of patriarchal estates, and little ever comes into market except by reason of the division of estates and the necessity of paying off legacies, when the oak is cut and sent into the market as a means of raising ready money. Massachusetts oak is of excellent quality.

A small supply of oak is still to be found in the state of Connecticut; but ship-building has almost ceased in that state, and were the industry ever to reach considerable proportions again the supply would not last more than a few years.

A large part of New Jersey was originally covered with the finest white oak, but the clearing of the land for cultivation and the use of oak in the general arts has nearly removed the timber from the state. For a long period forests of this timber flourished almost untouched in the southern part of the state, but the railroads have made it accessible, and it is disappearing at a rapid rate. There are only a few places left where oak timber of any size can be cut. A little of it can be found in the vicinity of May's Landing, there being several hundred trees of large size in and around that village from 12 to 25 inches in diameter and ranging in age from 80 to 200 years. There is also a good deal of the timber in the vicinity of Maurice river, where for the last thirty-five years a considerable number of fishing and coasting vessels have been built every year; but practically the white oak is so nearly extinct in New Jersey that, except on Maurice river, the builders do not depend upon it for the frames of their vessels. The sloops, schooners, and brigantines built in eastern New Jersey are nearly all framed with Jersey yellow pine; the planking and center work only are of oak.

The largest oak forest now existing, growing close upon the Atlantic coast, is on the peninsula of Delaware and in the states of Maryland and Virginia. This region has been resorted to by the ship-builders of Maine, Massachusetts, and New York for more than fifty years. The timber originally covered the whole face of the country from the Delaware river to Chesapeake bay and beyond, and the trees were so tall that the majority of them would yield logs 2½ feet square and 60 feet in length without a spot or defect, the moist lands in which they grew and the exposure to the breezes of the sea being particularly favorable to the production of durable timber. Delaware and Maryland white oak became famous more than fifty years ago for its lasting quality and its general excellence. The possession of this abundant supply of cheap timber led to no great development of the ship-building industry of the states in which it grew; nine-tenths of all the oak felled upon the peninsulas has been cut for exportation to northern markets or to Europe. Serious inroads had already been made into the supply at the time of the war of 1861, and during that war, to supply the demands of the navy, an immense quantity of it was cut. At one time there was serious apprehension of the entire failure of the supply of large timber, and large quantities of it were cut and transported to the north for storage in the navy-yards, so that at least the government should not be without material for building vessels. At least one-half of the face of the country on the Delaware, Maryland, and Virginia peninsulas is still covered with a thick growth of oak trees, but nearly all the first growth near navigable water has now been removed. It is supposed that Worcester county, Maryland, has more oak than any other locality at present, as there was very little cut in that county before the railroad was built through it a few years ago; but since a way of transportation has been opened wood-cutters have been operating there vigorously. There is now very little good ship-timber left in eastern Maryland, except in that county, and it is estimated that in twenty years' time, at the present rate of consumption, the whole supply of large pieces for ships' frames will have been destroyed. The growing scarcity of large trees is illustrated in part by the rise in price of timber standing upon the stump. In times past it has been bought for $1 a thousand feet, standing in the tree, and even at the present time, in counties having a great deal of it, the price is sometimes as low as that; but the usual price at present is seldom lower than $3, even in places where it is difficult to get it out, the average from $4 to $10 a thousand, and before the trees have been felled, hewed into frame timber, and transported by water to Maine the value has risen to $35 a thousand feet. If the second growth of oak in this region were as good as the first, and if the demand for the timber were limited to the requirements of the United States alone, it is probable that several generations would elapse before the price would rise much higher. But it is found, in the first place, that the second growth of oak is not so good as the first. Owing to the gradual clearing up of the country the soil has grown drier, or some other change has taken place which seems to affect the quality of the timber, and many of the local builders in Delaware and Maryland who are familiar with the timber resources of their states believe that the first growth of white oak can never be replaced and that the destruction of timber now going on is permanent. In the next place, the demand is not limited to the United States, Delaware and Maryland white oak being now sent to the Canadian provinces and to Europe in large quantities. The finest pieces, intended for keels, stems, stern-posts, rudder-posts, etc., are cut expressly for the Saint John's market, and this trade has grown so large as to hasten materially the disappearance of the timber.

There is good oak in the Alleghany region south of Pennsylvania extending nearly to Georgia, but it is too far away from the sea to be cut for ship-building while any considerable quantity remains in the coast counties of Delaware, Maryland, and Virginia, and, though cheap where it stands, the expense of bringing it down for shipment would be considerable.

Along the northern lakes the white oak has disappeared with the same rapidity as on the sea-coast. Originally the country was covered with almost one unbroken forest containing oak, pine, hemlock, and hard-wood from lake Champlain to the head of lake Superior; but in the place of this grand growth of timber there now exists an almost unbroken series of cleared and cultivated fields and thriving cities for a distance of more than a thousand miles. A few small forests remain, as in the Adirondack region in New York and on the peninsulas of Michigan and Wisconsin, and some oak remains scattered in small quantities all along through the tier of states bordering on the lakes, but nine-tenths of all the timber is gone. Professor Sargent predicts that what is left of some varieties will be cut off in twenty years, and one need only go into the ship-yards on the lakes to learn that an oak famine is impending. Even in Michigan, where the best white oak in the West is found, people are now importing timber to some extent from Canada in order to eke out the local supply, and more than one large owner of tonnage on the lakes has told me that on account of the diminution of the oak supply he expects to convert his property into iron vessels in the course of a few years. The western forests have been the more severely taxed for oak because that is the only good timber the builders of the lakes have had. They are too far from the southern market to buy pitch-pine, and their white pine is too soft and perishable for use in vessels except for decking, beams, houses, and spars. Lake vessels are framed, planked, and ceiled with oak. This fact, and the general demand for oak timber for houses, cars, and other local purposes, its exportation to the East and to Europe, the clearing up of the country, and the disastrous losses by forest fires, have caused the trees to disappear with remarkable rapidity. The wood has become so scarce that the price of flitch oak has risen from $10 per thousand board feet to $20 in the last twenty years, while squared oak has risen from $15 to $25 per thousand feet, and plank to $30 and $35 per thousand.

While speaking of oak, mention should be made of the forests of the Ohio River valley. The greatest hard-wood forest in the country originally grew over the face of the territory extending from Arkansas and Missouri eastward all along both sides of the Ohio river, and up the Cumberland, Tennessee, Kanawha, and other great branches of the Ohio to the mountains of Virginia, and over the mountains down to the coast. On the northern side of the Ohio the oak has been pretty well cut off, except in scattered lowlands; but on the southern side of the river, in West Virginia, Kentucky, Tennessee, and western North Carolina, and away west in Missouri and Arkansas, there is an abundance of white-oak timber. Now that coal is the popular fuel used on river steamboats and in railroad locomotives the felling of timber is going on more slowly, and some of the forests are practically uninvaded. There is probably more white oak in that region than in all the rest of the country put together, and there are immense tracts of trees of large size. The quality is not always so good as that of the coast oak, but there is enough timber growing in moist land to make the wood sufficiently sound for ship-building purposes. The unfortunate feature of the situation is that there is no practicable way of getting it down to market, as the only route to the sea-coast is by way of the Ohio and Mississippi rivers to New Orleans. It could be floated thither in rafts, as it now is to all points along the Ohio river, by felling a certain number of poplar trees, to float the rafts; but the distance is great, and the rafts would continually be lost in the swift current of the river or by getting aground on sand-bars. The scheme is financially too perilous to be attempted, and the cost of freight from New Orleans to the northern yards would in any event be a serious drawback. It is doubtful whether this timber can ever be much used for deep-sea ship-building unless the vessels are built upon the Mississippi river, for by the time that prices on the coast are so high as to warrant the rafting of it to New Orleans or the freighting of it overland by railroad it will probably be as cheap to build ships of iron as of white oak. A good deal of oak is indeed being sent in cars to the sea-board at the present time, but not for ship-building.

From this review it will be seen that the ship-building of the United States cannot probably depend upon the oak supply of the country for many years longer. Were shipping and trade what they were two hundred years ago, the supply might last a long time; but there has been a great change since America was first settled, and timber is now being consumed in a more rapid ratio than formerly. In old times vessels were small. A 400-ton ship was a monster, and a thousand small vessels were a great fleet, worthy of national pride. Less than 200,000 feet of timber would build a large vessel of the days of the pilgrims; on the other hand, at the present time, the coasting schooners of ordinary size require from 300,000 to 400,000 feet of lumber, and the barks and deep-sea ships from 700,000 to 950,000 and even 1,100,000 feet each. That is to say, every large ship requires the felling of from 160 to 250 trees which are from 100 to 250 years old, a growth which could not be replaced in the life-time of less than four generations. Not only are vessels larger, but there are more of them than there were two centuries ago; and the larger the vessels the heavier the scantling in proportion, and more timber is used in repairing and rebuilding them. Besides the wood consumed by the vessels themselves, a great quantity is cut annually for the building and repairing of wharves and piers in the harbors in which shipping is employed, and the trees cut for those objects are unfortunately the younger ones. The forests are thus being stripped of both large and small trees. No opportunity is given them to recuperate, so that while the consumption of white oak is far greater in proportion to the number of vessels built than it was 200 years ago, the circumstances are also such that it is almost impossible to entertain the slightest hope of ever replacing the timber when it has finally been cut off.

Second only to white oak in importance in ship-building on the Atlantic coast is the yellow pine of the southern states. This tree is properly the yellow or long-leaf pine, and all from Virginia southward is of this variety. In the ship-yards it is called indiscriminately "pitch-pine" and "yellow pine"; but the yellow or pitch-pine of New Jersey is another variety. The southern pine is a tree from 60 to 80 feet in height, with a trunk from 2 to 4 feet in diameter and the grain coarse but compact and straight, and having far less sap-wood than the northern varieties, such as the pines of Virginia and New Jersey. The wood is heavy, strong, and rigid, is full of turpentine, and holds iron tenaciously, being also free from the acids which destroy an iron bolt. It does not grow much more than 100 miles inland from the sea-coast, but for at least that distance it forms almost an unbroken belt of timber from the southern boundary of Virginia all the way to Texas, skipping, however, the lower part of Louisiana. It has been cut off only along the course of the railroads and the rivers of the several states in which it is found. In Mississippi and Alabama the trees do not stand so thickly as in the other states, and are consequently larger and finer. The supply of this valuable timber is very great. It is used principally in the planking, ceiling, keelsons, water-ways, rails, and beams of vessels, and occasionally for decking and spars. Lower masts, with a core of oak and an outside of yellow pine, bolted and hooped together, are now commonly made for the large ships, and topmasts are frequently made of a single pitch-pine stick. The timber is cheap in the states in which it grows, and it is surprising that it is not utilized there for a great local ship-building industry. In a 2,000-ton ship, consuming 900,000 or 1,000,000 feet of timber, as now built in Maine, there is from 150,000 to 200,000 feet of oak, white pine, and hackmatack, and 750,000 or 800,000 feet of southern pitch-pine. It would be cheaper to freight the oak, white pine, and hackmatack to the south than to freight the vastly larger quantity of pitch-pine north. If the straight-grained pitch-pine can be used for frame timber, the whole ship could be built in the South at a large saving on northern prices, probably for from $35 to $40 per register ton. Builders and insurance companies seem afraid of pitch-pine frames, but possibly this is because the experiment has not been tried.

Next after pitch-pine the timber most valued by shipbuilders in this country is white pine. This valuable tree occupies common territory with other timber in the region extending from the valley of the Saint Lawrence to beyond the great lakes, and southward along the Alleghany Mountain system to the high ridges of Georgia. In old times the supply was immense. The trees are from 80 to 150 feet in height, those full grown being from 3 to 4 feet in diameter near the butt. The wood is soft, clear, free from knots, susceptible of a beautiful polish when worked, and extremely buoyant when placed in the water; but it is not strong enough for frame timber, and there is no record of its ever having been used for that purpose in this country. A few ships were built in England of white pine during the period of the greatest alarm there about the failure of the oak supply; but as these vessels lasted for an average of only three years, the experiment with that timber was not repeated.

White pine is most suitable for decking and the construction of cabins, as also for masts and spars. Its value for the latter use has always been so great that in the early patents granted to the colonies the trunks suitable for masts were reserved to the crown. A surveyor of the woods was appointed, who was given a license to go into the forests and mark such trees as were suitable for naval use. In a general way, trees of a diameter of 24 inches and upward just above the butt were reserved for the king, and persons who should fell one of them without permission were liable to a fine of £100. It is noted by Hutchinson that a pine, which when felled and sawed into boards would be worth scarce twenty shillings, would bring £20 when sold for a mast. The cost of masts and spars in England in that period was high. The following were the prices of American pine delivered at the yards in England in 1770, obtained from an old history:

MASTS.			BOWSPRITS.			YARDS.		
Diameter.	Length.	Value.	Diameter.	Length.	Value.	Diameter.	Length.	Value.
Inches.	*Feet.*	£ s.	*Inches.*	*Feet.*	£ s.	*Inches.*	*Feet.*	£ s.
36	108	110 0	38	75	48 0	25	105	25 12
35	105	88 0	37	75	42 0	24	102	25 12
34	102	72 0	36	73½	36 0	23	96	20 8
33	99	56 0	35	70½	34 0	22	93	16 16
32	96	44 16	34	69	32 0	21	88½	14 8
31	93	35 4	33	67½	24 16	20	84	11 12
30	90	28 0	32	64½	23 4	19	81	9 4
29	87	22 8	31	63	20 16	18	76½	7 4
28	87	18 8	30	61½	16 0	17	73½	5 4
27	87	14 8	29	58½	12 0	....	....	....
26	84	12 16	28	57	6 16	....	....	....
....	....	....	27	55½	5 7	....	....	....
....	....	....	26	52½	4 16	....	....	....

In 1768, 36-inch masts were worth £153 each delivered at the king's yards in England. In 1789 the lower masts of a 90- or 74-gun war ship, made from spindles of hard wood hooped and bolted together, cost from £500 to £525 each, the topmast, single sticks, £50 each, and the maintop-gallant masts from £8 to £9. From these figures it will be understood what a boon to England was the discovery of the magnificent white-pine timber of the American coasts.

In order to encourage the importation of spars liberal bounties were granted by act of parliament, and there were annually shipped from Portland, Maine, Portsmouth, New Hampshire, and a few other New England ports an average of about fifty ship-loads of spar-timber per year until after the revolutionary war.

The white pine was one of the first trees to disappear from the New England coast, and it is now so nearly extinct that builders are obliged to depend upon sources of supply hundreds and even thousands of miles away. New Hampshire, Vermont, New York, Pennsylvania, Ohio, and Michigan have been successively resorted to, and within the last five years two cargoes of spars have been brought from Oregon. Pitch-pine spars are now being brought to New England from Georgia. There is no prospect that trees large enough for masts will ever again be raised in Maine. In New Hampshire, Vermont, and other northern states, and as far west as Michigan, the white pine is also practically exhausted, while in Michigan, Wisconsin, and Minnesota, where there are many very large pine trees in the mixed hard-wood forests, timber-cutting is going on so fast by means of saw-mills and other steam apparatus that the extinction of the big timber is now expected within the present generation. Professor C. S. Sargent, census expert in charge of the forestry investigation, reports that it is probable that the large specimens of white pine in Michigan, Wisconsin, and Minnesota will be totally exterminated within the next ten or twelve years. It has already become cheaper for the Maine men to make their masts from strips of yellow pine and oak, bound securely together with iron hoops, than it is to bring white-pine trees from the distant parts of the country in which alone they are at present found. Lower yards on large ships are now often made of two sticks spliced, and topmasts are made of yellow pine. Iron masts and yards are now being introduced.

The "hard-wood" supply of the eastern and middle states is also nearly exhausted. These woods, comprising beech, birch, maple, and chestnut, were extensively used during the early active building times, and are still used to some extent in the timbers, beams, and planking of vessels; but there is very little of that timber left, and it cannot now be relied upon as a resource of any value for the ship-building industry. It is true that a large area of primitive forest land exists in the northern part of Maine, covering from 12,000 to 14,000 square miles of territory. Professor Sargent says that the timber is principally black spruce, with some scattered second growth pine and scattering bodies of hard wood, of which the yellow birch and the sugar maple are the most valuable, and it is possible that the future construction of railroads may make this region a factor of some importance in the future of the shipping industry in Maine, but the prospect is that the northern forests of the state will not become accessible for many years to come, as the logs are too heavy to drive down the rivers, and there is now no other way of getting them out. It ought, perhaps, to be mentioned that there is much hard wood in the north of Michigan.

A good ship-building wood, which was not much used by the early builders but has been put into ships extensively of late years, is the larch, variously called "hackmatack" and "tamarack". The wood of this tree is light colored, tough, buoyant, and durable, and a large vessel built completely of this wood would carry at least 300 tons more freight than an oak-built ship. It is not strong enough, however, to be used in parts of ships exposed to stress, and the uses for which it has been found most valuable are for knees, stanchions, and top timbers. The hackmatack has the valuable peculiarity of being free from acids which will corrode iron bolts driven through it. It holds iron with a tenacious grip. In these respects it is far superior to oak, and on account of its buoyancy, tenacity, and durability nearly all the Atlantic ship-yards use it, when it can be obtained, in the tops of vessels, as the cargo-carrying power is slightly increased and the center of gravity of the ship is kept low. On the northern coast the larch is sometimes from 80 to 100 feet in height, with the trunk sometimes 2 and 3 feet in diameter, and always grows in the swamps. A considerable body of this timber exists scattered through the northern counties of Maine, but it is so far away from the railroads that it is inaccessible. The larch is a tree of quick growth. A tract of it once cleared off springs up again immediately, and in about ten or fifteen years' time the trees are large enough for knees for the smaller class of vessels. There is apparently no reason why larch may not be relied upon for a long period for the use to which it is now chiefly put.

Spruce, too, like all other forest trees of the north Atlantic coast, is fast disappearing. It has never been used within the limits of the United States to any great extent in ship-building except for the light spars of vessels, but in the Canadian provinces forests are found of coast-spruce strong, tough, and durable which have been extensively utilized for the construction of vessels. The timber is cheap, and a ship when built of it is a good carrier and of remarkable durability for one constructed of so soft a timber. A number of small vessels built in the eastern part of Maine have also been constructed largely of spruce, but that is believed to be the only locality in the whole of the United States where spruce has been so used. For the light spars of vessels this wood is invaluable, as it is as light as white pine or cedar and is elastic and strong. A great deal of it was exported in the colonial days to England, and even at the present time a large number of European vessels are supplied with spruce spars from America, but the timber is now scarce. The chief sources of supply are Canada, Maine, New Hampshire, Vermont, northern New York, and West Virginia. A system prevails in Maine of cutting only the large trees from the spruce woods, leaving the smaller ones; and as the tree is one of rapid growth, the woods can be profitably worked at intervals of from fifteen to twenty-five years.

One other ship-building wood grows upon the Atlantic coast in limited supply, and has been used to some extent for a hundred years. This is the live-oak of Florida, a timber so durable that a ship built of it would last a hundred years, but so heavy as to make its use undesirable. A great deal of this timber was utilized during the twenty years following 1840 in navy vessels, steam propellers, and large clipper ships, particularly in the bows and sterns. Two large vessels have been built on Long Island within the last five years with live-oak frames, but experience has proved that vessels into which this wood enters to any considerable extent are inferior cargo carriers. Live-oak vessels have, as a rule, changed hands faster than those built of any other wood. There is a good deal of this timber left in Florida, but no one wants it.

Speaking in a general way, it must be admitted that the supply of valuable ship-building timber on the Atlantic coast has been materially impaired by the past two centuries of steady pillaging; and it is diminishing now so fast that wooden ships are likely to rise materially in price in the course of the next twenty years. If relief is to be looked for from any quarter, it is probable that it will come from the far northwest, on the Pacific coast.

Washington territory and Oregon, west of the Cascade mountains, are covered with the heaviest continuous belt of forest growth now existing in the United States, and perhaps in the world. Perhaps the single exception to this remark is the magnificent redwood belt of the California ranges. Nine-tenths of the forests first named are the yellow or red fir. There is a valuable cedar and several varieties of pine are scattered among the firs; there are also hemlock, spruce, a poor quality of oak, and some laurel. The tide-land spruce of that region makes excellent knees, and the laurel supplies stem pieces and other parts of the ship for which hard wood is positively required. The fir is valuable for all the rest of the ship. The trees grow to gigantic size, being from 150 to 300 feet in height, with the trunk from 5 to 8 and even 10 feet in diameter. They grow so straight that the lumbermen often fail, even with the aid of a plumb-line, to discover the slightest deflection from a true perpendicular. The wood is lighter and coarser grained than white oak, but is as strong, elastic, and tough as oak, and when cut at the right season of the year is equally as durable.

This timber first came to the notice of the officers of the United States navy more than thirty years ago. One or two war vessels having been sent into Puget sound to protect the settlers from the Indians, the officers were captivated with the timber, growing as it did from the water's edge as far inland as the eye could reach, and running up even on the sides of the colossal peaks of the region. Word being sent to Washington that it seemed desirable to test the qualities of the wood for ship-building, Admiral Farragut caused a quantity of it to be sent to the navy-yard near San Francisco and special tests to be made, with a view to ascertaining the size of scantling required to construct a vessel of fir having the same strength as though it were built of eastern white oak. Specifications for the sloop-of-war Manzanita were prepared from the results of these experiments. The fir was tested both there and at various eastern yards and found to be a satisfactory material for wooden vessels.

The following is an extract from a report by Constructor George W. Much, of the United States navy, in January, 1879, to Rear-Admiral Rodgers, on this subject:

In compliance with bureau order of October 12, 1878, to furnish the information required in your letter of October 3, 1878, relative to amended specifications for building the screw-steamer Manzanita with the Atlantic coast wood crossed out, also whether the carbolized laurel in the yard schooner Freda remains perfectly sound, etc., I have the honor to report that upon the receipt of the order I instituted inquiries as to the best Pacific coast and other woods that could be obtained in San Francisco for ship-building purposes, and by the information received from old settlers, timber dealers, vessel-owners, ship-builders, shipwrights, and others conversant in timber and timber material, find from their experience that there is no material on this or the Atlantic coast better adapted for outside and inside planking, for keels, keelsons, clamps, bilge strakes, knees, and breast-hooks than the Washington territory yellow fir, or yellow Oregon pine. It has also been adopted for frame timber in all vessels built on the coast for the last ten years, and so far with good results, and I have therefore adopted it in the specifications.

The Washington territory yellow fir or Oregon yellow pine can be readily procured, free from sap or other defects, of any desired size up to 90 feet in length, is in strength fully equal to Atlantic coast white oak, and has fully the same tenacity to hold fastening, and never becomes iron sick as it does when corroded by the acid contained in white oak. The great length of the Washington territory yellow fir saves to the ship-builder in fastening butts and scarfs and gives greater elasticity to the hull, and consequently diminishes the danger of springing a leak. Owing to the straight growth of this timber, there are comparatively but few natural crooks, but by judicious and careful selection the proper growth or shape could be obtained from the larger trees, and, if they were not readily found, the sharper floors, futtocks, and hooks could be built in the same manner as those built at this yard for the United States schooner Freda. For mast and spar timber the Washington territory yellow fir has no superior. Shipwrights and ship-builders of this coast, from their experience in repairs to sail and steam vessels, fully indorse the lasting qualities of this wood. Innumerable instances might be given of vessels built on this coast constructed entirely of Washington territory yellow fir. Some of them built as early as 1857 are still remaining perfectly sound, strong, and staunch.

The length of the fir timber is a strong point in its favor, as from trees 300 feet in height sticks of any required length can be obtained, while on the Atlantic coast oak and hard wood cannot be bought of a greater average length than 45 feet. Plank and logs of 60 feet are costly and hard to get; on the other hand, in the yellow-fir region logs for keels, keelsons, and planking can be obtained of any length that the saw-mills can handle. Keel and keelson pieces from 110 to 120 feet in length are habitually used. In the transfer steamboat Solano, of 3,549 tons, built at Oakland in 1879 and 1880, keelson pieces were used 150 feet long and 24 inches square without a particle of sap, rent, or check, and sound, straight, and free from knots and defects of every kind. In the curved parts of frames no longer sticks can be employed than in the eastern yards, but in all the longitudinal pieces of the ship, upon which the rigidity of the hull depends, the builders find it convenient to use stuff of an average length of 90 feet, and can get all they want of it without extra cost. The long stuff is preferred, because it gives strength and elasticity to the ship, and because it saves much labor in construction, owing to the fewer number of butts.

Professor Sargent says that any estimate of the actual amount of timber standing in the territory is scarcely possible with the existing knowledge of the country; but the area of the forests is enormous, and the quantity of timber to the acre is remarkable. One estimate of the quantity of timber standing, apparently an extravagant one, makes it equal to the whole amount of the wood cut in the United States from the first settlement down to the present time. An important fact about the Pacific fir is that it reproduces itself so fast in its rainy home that it can be made to last almost indefinitely.

A large number of coasting vessels have been built out of Pacific coast fir, and several ships have been constructed for the grain trade with Liverpool. There was a great difference in the length of time for which these vessels respectively lasted. Some speedily decayed, others were sound after twenty years' use, and builders were for a few years greatly puzzled to account for this phenomenon; but attention has been called of late to the time of year at which the timber for the different vessels was cut, and it is now believed that the trouble in the cases of early decay arose entirely from using summer-cut trees. Builders intend hereafter to select fall- and winter-cut timber for their vessels, and the experts of the Pacific coast believe that fir felled when the sap is out of the wood and salted after being put into the vessel will last as long as white oak.

The cost of fir will also have some bearing on the question of iron or wood as a material for sailing vessels. As long as it can be bought for $10 and $12 per thousand board feet or less than $25 or $30 a thousand, while iron costs anything like present prices, the wooden ship will be a cheaper vessel than one of iron.

The following is a statement of the specific gravities and weights of the ship-building woods of the United States, prepared for this report by Professor C. S. Sargent, of Brookline, Massachusetts, chief special agent in charge of forestry statistics of the census of 1880:

Woods.	Specific gravity.	Weight per cubic foot.	Woods.	Specific gravity.	Weight per cubic foot.	Woods.	Specific gravity.	Weight per cubic foot.
		Pounds.			*Pounds.*			*Pounds.*
White oak	0.7438	46.35	Live oak	0.9504	59.23	White laurel	0.6517	40.61
Pitch-pine of New England	0.4957	30.89	Chestnut	0.4504	28.07	Western white cedar	0.4623	28.81
Jersey pine	0.4957	30.89	Locust	0.7333	45.70	Cedar of Puget sound	0.3796	23.64
Southern pine	0.6999	43.62	Rock maple	0.6827	42.53	Alaska cedar	0.4782	29.80
White pine	0.3842	23.94	Black sugar maple	0.6921	43.13	Southern cypress	0.4600	28.67
White cedar	0.3322	20.70	American beech	0.6883	42.89	Madeira wood	0.9533	59.41
Red cedar	0.4926	30.70	Yellow birch	0.6553	40.84	Horse-flesh dogwood	0.8734	54.43
Hemlock	0.4202	26.19	Southern poplar	0.3889	24.23	Mastic	1.0109	63.00
Hackmatack	0.6236	38.86	Yellow fir	0.5155	32.13			
Black spruce	0.4584	28.57	Redwood	0.4208	26.22			

These are the weights of absolutely dry woods; for woods used for ordinary industrial purposes an addition of from 10 to 15 per cent. should be made for moisture remaining in the wood. For ship timber the weights should be corrected by adding about 25 per cent. For instance, white oak partially seasoned weighs on the average 56 pounds per cubic foot, and yellow fir 42 pounds per cubic foot in the ship-yard.

Constructor Samuel H. Pook, of the United States navy, has supplied the following data of actual weights of woods in the ship-yards:

	Weight per cubic foot in pounds.
White oak	56
Pitch-pine	40 to 50
White pine	35
Spruce	33
Maple	40
Beech	49
Live oak	76
Hackmatack	42
Chestnut	36
Hemlock	30
Sycamore	35
White holly	47
White cedar	21
Red cedar	35
Cypress	31
Hickory	53

CHAPTER IX.

STATISTICS OF SHIP-BUILDING.

NUMBER, TONNAGE, AND VALUE OF NEW VESSELS, AND NUMBER AND VALUE OF BOATS BUILT DURING THE CENSUS YEAR, BY STATES AND TERRITORIES.

State and Territory.	NEW VESSELS. (a)			BOATS.		CANAL-BOATS. (b)			Value of repairing.	Total value of all products.
	Number built.	Tonnage.	Value.	Number built.	Value.	Number built.	Tonnage.	Value.		
The United States	2,415	498,878	$19,225,714	8,026	$876,999	643	66,707	$1,739,975	$16,697,614	$36,800,327
Alabama	....	....	....	....	....	....	....	....	60,000	60,000
Arkansas	3	300	28,000	....	....	....	....	....	....	28,000
California	21	7,361	770,696	200	57,545	....	....	....	969,398	1,797,639
Connecticut	52	11,473	418,009	280	37,200	....	....	....	317,451	767,660
Delaware	55	31,123	1,614,969	100	18,437	....	....	....	529,097	2,162,503
Florida	13	217	25,000	45	16,050	....	....	....	44,000	85,050
Georgia	2	539	17,000	....	....	....	....	....	....	17,000
Illinois	11	1,397	137,300	85	9,050	1	88	8,300	745,743	892,093
Indiana	64	26,524	726,680	52	3,100	....	....	....	80,875	810,655
Iowa	2	860	70,000	....	....	....	....	....	42,000	112,000
Kansas	1	178	26,000	....	....	....	....	....	....	26,000
Kentucky	23	2,130	86,215	25	1,000	....	....	....	161,800	249,015
Louisiana	36	1,231	105,525	80	15,600	....	....	....	222,400	343,525
Maine	88	41,396	2,174,650	970	53,818	....	....	....	681,378	2,909,846
Maryland	131	7,499	320,260	133	45,000	60	4,270	84,000	1,423,370	1,788,630
Massachusetts	39	5,605	391,655	3,765	186,727	....	....	....	1,703,284	2,281,666
Michigan	69	15,909	1,390,050	210	13,117	....	....	....	631,469	2,034,636
Minnesota	....	....	....	....	....	....	....	....	15,000	15,000
Mississippi	3	33	3,500	....	....	....	....	....	2,000	5,500
Missouri	17	3,451	358,487	....	....	....	....	....	206,700	565,187
Nebraska	1	52	9,000	....	....	....	....	....	....	9,000
New Hampshire	....	....	....	44	4,440	....	....	....	25,630	30,070
New Jersey	53	7,455	409,714	134	34,460	10	1,010	14,600	940,455	1,384,029
New York	635	76,418	3,145,536	1,221	263,957	441	40,887	1,370,525	4,575,551	7,985,044
North Carolina	8	487	22,650	....	....	....	....	....	34,569	57,219
Ohio	55	25,132	1,127,600	91	18,400	1	11	2,300	406,210	1,552,210
Oregon	10	2,162	176,600	....	....	....	....	....	29,900	206,500
Pennsylvania	802	204,507	4,676,258	318	47,888	122	10,711	237,450	1,965,324	6,689,470
Rhode Island	17	379	129,000	68	27,610	....	....	....	360,431	517,041
South Carolina	27	1,615	92,900	....	....	....	....	....	51,100	144,000
Tennessee	1	48	5,000	....	....	....	....	....	....	5,000
Texas	16	758	55,780	....	....	....	....	....	22,000	77,780
Vermont	5	550	17,800	....	....	5	550	17,800	....	17,800
Virginia	26	514	62,050	48	9,800	3	180	5,000	109,174	181,024
Washington	14	1,769	161,600	80	1,900	....	....	....	21,000	184,500
West Virginia	85	16,727	221,230	....	....	....	....	....	9,900	231,130
Wisconsin	21	3,079	254,000	77	11,900	....	....	....	310,405	576,305

a Includes wooden and iron vessels and canal-boats. b Included with new vessels.

NUMBER, TONNAGE, AND VALUE OF NEW VESSELS, AND NUMBER AND VALUE OF BOATS BUILT DURING THE CENSUS YEAR, BY COUNTIES.

States and counties.	NEW VESSELS. (a)			BOATS.		CANAL-BOATS. (b)			Value of repairing.	Total value of all products.
	Number built.	Tonnage.	Value.	Number built.	Value.	Number built.	Tonnage.	Value.		
ALABAMA.										
Mobile									$60,000	$60,000
ARKANSAS.										
Johnson	1	125	$12,000							12,000
Pulaski	1	86	8,000							8,000
Sebastian	1	89	8,000							8,000
Total	3	300	28,000							28,000
CALIFORNIA.										
Alameda	5	5,964	638,296						51,000	689,296
Humboldt	1	347	15,000							15,000
Mendocino									5,500	5,500
San Francisco (city)	15	1,050	117,400	200	$57,545				912,898	1,087,843
Total	21	7,361	770,696	200	57,545				969,398	1,797,639
CONNECTICUT.										
Fairfield	3	68	10,300	34	2,320				11,500	24,120
Hartford									32,600	32,600
Middlesex	2	228	10,000	13	1,625				135,502	147,127
New Haven	34	4,486	128,000	65	6,666				30,660	165,326
New London	13	6,601	264,700	168	26,580				107,189	398,487
Total	52	11,473	413,000	280	37,200				317,451	767,660
DELAWARE.										
Kent	1	400	12,000							12,000
New Castle	44	27,704	1,432,669	100	18,437				523,097	1,974,203
Sussex	10	3,019	170,300						6,000	176,300
Total	55	31,123	1,614,969	100	18,437				529,097	2,162,503
FLORIDA.										
Duval				10	3,050					3,050
Franklin	4	32	3,400							3,400
Hernando	1	19	5,000							5,000
Hillsborough	1	11	1,800							1,800
Levy	1	6	450	15	5,000				6,000	11,450
Manatee	1	13	1,500						5,000	6,500
Marion	1	94	9,000							9,000
Monroe	3	29	2,850	20	8,000				33,000	43,850
Volusia	1	13	1,000							1,000
Total	13	217	25,000	45	16,050				44,000	85,050
GEORGIA.										
Glynn	1	243	8,000							8,000
Telfair	1	296	9,000							9,000
Total	2	539	17,000							17,000
ILLINOIS.										
Alexander									9,860	9,860
Cook	3	138	16,200	85	9,050	1	88	8,300	633,883	659,133
Jasper	1	10	2,000							2,000
Jersey	1	102	12,000							12,000
Massac	3	750	59,500						40,000	99,500
Peoria	2	68	6,600							6,600
Pulaski	1	329	41,000						62,000	103,000
Total	11	1,397	137,300	85	9,050	1	88	8,300	745,743	892,093
INDIANA.										
Clark	28	17,010	489,700	40	2,500				17,000	509,200
Daviess	1	28	2,800							2,800
Floyd	7	5,307	65,700							65,700
Hendricks	1	49	4,500							4,500
Jefferson	6	3,006	110,000						40,000	150,000
Martin	1	28	4,000							4,000
Perry									2,500	2,500
Switzerland	1	28	4,000							4,000
Tippecanoe	1	20	3,000							3,000
Vanderburgh	17	1,016	38,980	12	600				21,375	60,955
Warrick	1	23	4,000							4,000
Total	64	26,524	726,680	52	3,100				80,875	810,655

a Includes wooden and iron vessels and canal-boats.

b Included with new vessels.

NUMBER, TONNAGE, AND VALUE OF NEW VESSELS, ETC.—Continued.

States and counties.	NEW VESSELS. (a)			BOATS.		CANAL-BOATS. (b)			Value of repairing.	Total value of all products.
	Number built.	Tonnage.	Value.	Number built.	Value.	Number built.	Tonnage.	Value.		
IOWA.										
Dubuque	2	860	$70,000						$42,000	$112,000
KANSAS.										
Leavenworth	1	178	26,000							26,000
KENTUCKY.										
Barren	1	23	3,000							3,000
Boyd	3	185	15,000	25	$1,000				8,000	24,000
Franklin	1	60	6,500							6,500
Jefferson	1	80	30,000						15,000	45,000
Kenton	16	1,861	29,715						58,800	88,515
McCracken									80,000	80,000
Union	1	21	2,000							2,000
Total	23	2,180	86,215	25	1,000				161,800	249,015
LOUISIANA. (c)										
Calcasieu	3	86	13,925							13,925
Catahoula	1	11	6,000							6,000
Claiborne	1	18	8,000							8,000
Iberville	3	13	950							950
Jefferson	2	35	6,500							6,500
Orleans	7	250	25,050	80	15,600				222,400	263,050
Rapides	1	84	9,000							9,000
Saint Landry	1	21	8,000							8,000
Saint Mary	9	603	18,300							18,300
Saint Tammany	6	88	7,600							7,600
Tangipahoa	1	13	1,500							1,500
Terrebonne	1	9	700							700
Total	36	1,231	105,525	80	15,600				222,400	343,525
MAINE.										
Aroostook				80	2,000					2,000
Cumberland	8	7,125	401,442	225	11,950				189,718	603,110
Hancock	10	1,580	84,480	124	5,435				85,784	175,699
Knox	9	6,297	306,550	79	6,395				133,014	445,959
Lincoln	5	1,477	78,600	14	1,135				32,264	111,999
Penobscot				130	4,806				57,821	62,217
Sagadahoc	32	20,223	986,758	58	10,640				79,530	1,076,928
Waldo	1	350	14,000	15	900				18,755	33,655
Washington	10	838	61,100	201	8,776				71,992	141,868
York	13	3,506	241,720	44	1,691				13,000	256,411
Total	88	41,396	2,174,650	970	53,818				681,378	2,909,846
MARYLAND.										
Allegany	59	4,140	80,600			59	4,140	$80,600	30,500	111,100
Anne Arundel									4,000	4,000
Baltimore (city)	23	2,162	136,210	80	23,900				1,284,970	1,445,080
Calvert									5,300	5,300
Cecil	1	130	3,400			1	130	3,400		3,400
Dorchester	13	374	31,400	6	2,300				18,200	51,900
Harford	1	22	3,000						25,000	28,000
Queen Anne	1	6	900							900
Saint Mary's	2	30	3,500							3,500
Somerset	9	121	10,850	20	8,000				7,200	26,050
Talbot	11	135	14,100	12	4,800				11,200	30,100
Wicomico	6	101	14,800	15	6,000				16,000	36,800
Worcester	5	218	21,500						21,000	42,500
Total	131	7,499	320,260	133	45,000	60	4,270	84,000	1,423,370	1,788,630
MASSACHUSETTS.										
Barnstable				72	14,075				45,823	59,898
Bristol	1	12	1,000	285	28,047				202,739	231,786
Dukes				6	1,910				47,569	49,479
Essex	17	1,761	131,050	2,951	73,799				180,485	385,334
Middlesex				46	7,500					7,500
Norfolk	2	938	48,000	259	14,850					62,850
Plymouth				6	1,171				2,500	3,671
Suffolk	10	2,304	211,605	170	43,375				1,224,168	1,479,148
Worcester				20	2,000					2,000
Total	30	5,005	391,655	3,765	186,727				1,708,284	2,281,666
MICHIGAN.										
Allegan	1	23	3,500							3,500
Alpena	1	6	1,500							1,500
Berrien	4	409	41,200							41,200
Huron	6	80	6,800							6,800
Iosco	1	403	18,000							18,000

a Includes wooden and iron vessels and canal-boats.   b Included with new vessels.   c Parishes.

NUMBER, TONNAGE, AND VALUE OF NEW VESSELS, ETC.—Continued.

States and counties.	New vessels. (a)			Boats.		Canal-boats. (b)			Value of repairing.	Total value of all products.
	Number built.	Tonnage.	Value.	Number built.	Value.	Number built.	Tonnage.	Value.		
MICHIGAN—continued.										
Macomb	4	759	$57,500							$57,500
Manistee	1	22	2,000							2,000
Manitou	1	11	950							950
Mason	1	12	900							900
Muskegon	2	84	4,800							4,800
Ottawa	9	681	87,850						$17,900	105,750
Saginaw	14	5,314	340,550	87	$2,950				71,000	414,500
Saint Clair	7	644	34,900	30	1,992				118,169	155,061
Sanilac				10	2,100					2,100
Van Buren	4	96	4,600							4,600
Wayne	13	7,415	785,000	83	6,075				424,400	1,215,475
Total	69	15,909	1,390,050	210	13,117				631,469	2,034,636
MINNESOTA.										
Washington									15,000	15,000
MISSISSIPPI.										
Hancock	1	17	2,000							2,000
Harrison	2	16	1,500						2,000	3,500
Total	3	33	3,500						2,000	5,500
MISSOURI.										
Butler	1	86	8,000							8,000
Clay	1	29	9,000							9,000
Cole	1	42	7,000							7,000
Gasconade	1	91	9,000							9,000
Howard	2	109	10,475							10,475
Jackson	1	48	15,000							15,000
Saint Louis (city)	10	3,046	300,012						206,700	506,712
Total	17	3,451	358,487						206,700	565,187
NEBRASKA.										
Cass	1	52	9,000							9,000
NEW HAMPSHIRE.										
Rockingham				44	4,440				25,630	30,070
NEW JERSEY.										
Atlantic	4	48	5,100						1,300	6,400
Burlington	6	259	10,400	4	1,820	1	200	$1,800	13,400	25,620
Camden	11	2,130	200,087	26	8,000				230,489	438,576
Cape May	7	896	30,200							30,200
Cumberland	6	1,870	112,300						19,400	131,700
Essex									22,500	22,500
Gloucester	1	19	2,500							2,500
Hudson	2	300	6,000	78	21,050				516,716	543,766
Mercer									31,000	31,000
Middlesex	1	164	9,000						54,750	63,750
Monmouth	10	882	16,800			9	810	12,800	20,000	36,800
Ocean	1	9	1,200	4	1,600					2,800
Union	4	1,360	16,127	22	1,990				30,000	49,017
Total	53	7,455	409,714	134	34,460	10	1,010	14,600	940,455	1,384,629
NEW YORK.										
Albany	7	793	22,800			6	780	18,300	90,000	112,800
Cayuga	1	132	3,600	13	2,850	1	132	3,600	7,350	13,800
Chautauqua	1	124	2,500			1	124	2,500		2,500
Clinton	6	722	24,600			6	722	24,600		24,600
Duchess	4	120	16,300							16,300
Erie	134	16,188	668,390	47	2,800	108	13,189	384,475	495,766	1,166,956
Essex	13	1,709	36,800			13	1,709	36,800	18,000	54,800
Greene	9	2,345	200,300						32,000	232,300
Herkimer									31,400	31,400
Jefferson	6	408	35,800							35,800
Kings	78	11,259	649,995	92	19,241				1,330,552	1,999,788
Lewis	4	160	6,800			4	160	6,800	2,200	9,000
Madison	8	1,052	27,600			8	1,052	27,600	17,387	44,987
Monroe	38	5,035	153,100	48	5,510	37	4,885	147,100		158,610
Montgomery									6,000	6,000
New York	2	18	2,100	642	163,360				1,905,545	2,071,005
Niagara	58	6,911	233,700			58	6,911	233,700	29,700	263,400
Oneida	22	2,196	62,900			20	1,931	50,900	21,476	84,376
Onondaga	7	850	23,800	12	1,100	7	850	23,800	5,800	30,700
Ontario				24	11,720					11,720
Orange	6	724	126,000						57,400	183,400
Oswego	33	4,517	113,200	22	1,190	31	4,117	92,400	31,173	145,563
Queens	1	8	1,200							1,200
Richmond	18	1,582	100,000	12	1,400				87,400	188,800
Rockland	3	130	21,000						9,000	30,000
Saint Lawrence				30	4,000				5,467	9,467
Saratoga	12	1,560	38,000			12	1,560	38,000	11,000	49,000
Schenectady									5,500	5,500
Schuyler	6	739	33,500	20	800	6	739	33,500		34,300
Seneca	1	130	3,500			1	130	3,500	4,600	8,100

a Includes wooden and iron vessels and canal-boats.

b Included with new vessels.

NUMBER, TONNAGE, AND VALUE OF NEW VESSELS, ETC.—Continued.

States and counties.	New vessels. (a)			Boats.		Canal-boats. (b)			Value of repairing.	Total value of all products.
	Number built.	Tonnage.	Value.	Number built.	Value.	Number built.	Tonnage.	Value.		
NEW YORK—continued.										
Suffolk	18	2, 567	$147, 750	124	$31, 040				$131, 188	$309, 978
Sullivan	18	1, 367	21, 950			18	1, 367	$21, 950	8, 000	29, 950
Tompkins	24	2, 938	86, 000			24	2, 938	86, 000		86, 000
Ulster	73	5, 634	157, 700			57	3, 697	70, 400	188, 847	846, 547
Warren				50	2, 000					2, 000
Washington	23	2, 894	64, 600			23	2, 894	64, 600	6, 000	70, 600
Wayne									3, 000	3, 000
Westchester	6	1, 606	60, 051	85	16, 946				33, 800	110, 797
Total	635	76, 418	3, 145, 536	1, 221	263, 957	441	49, 887	1, 370, 525	4, 575, 551	7, 085, 044
NORTH CAROLINA.										
Beaufort	5	395	14, 800						2, 060	16, 860
Brunswick									15, 500	15, 500
Craven	1	10	900							900
Dare									6, 000	6, 000
Pamlico	1	11	950							950
Pasquotank									11, 000	11, 000
Pitts	1	71	6, 000							6, 000
Total	8	487	22, 650						34, 560	57, 210
OHIO.										
Ashtabula	1	6	1, 000							1, 000
Brown	1	23	6, 000							6, 000
Columbiana	1	44	9, 000							9, 000
Cuyahoga	3	4, 940	286, 000	36	4, 200				228, 050	518, 250
Defiance									1, 200	1, 200
Erie	4	1, 503	114, 000	23	6, 300				9, 000	129, 300
Fairfield									3, 000	3, 000
Hamilton	18	13, 305	470, 000	(c)	2, 000				94, 700	566, 700
Jefferson	8	1, 447	9, 000							9, 000
Lawrence	4	435	41, 500						9, 000	50, 500
Lorain	6	776	60, 000							60, 000
Lucas	4	832	59, 300	32	5, 900				35, 100	100, 300
Scioto	1	1, 351	11, 000							11, 000
Stark									5, 000	5, 000
Summit	1	11	2, 300			1	11	2, 300	21, 160	23, 460
Washington	3	459	58, 500							58, 500
Total	55	25, 132	1, 127, 600	91	18, 400	1	11	2, 300	406, 210	1, 552, 210
OREGON.										
Benton	1	23	2, 800							2, 800
Clackamas									12, 000	12, 000
Clatsop	1	9	3, 000							3, 000
Columbia	1	16	3, 000							3, 000
Coos	1	51	3, 000							3, 000
Multnomah	11	1, 574	63, 300						7, 900	71, 200
Wasco	4	489	101, 500						10, 000	111, 500
Total	19	2, 162	176, 600						29, 900	206, 500
PENNSYLVANIA.										
Allegheny	508	132, 978	652, 840	80	5, 600				191, 400	849, 840
Armstrong (d)			8, 000							8, 000
Beaver	9	8, 332	234, 400							234, 400
Bucks	3	270	8, 400			3	270	8, 400	3, 000	11, 400
Carbon	13	1, 176	23, 400			13	1, 176	23, 400		23, 400
Clarion (d)			28, 580							28, 580
Columbia	3	221	24, 000			3	221	24, 000		24, 000
Dauphin				20	700					700
Delaware	5	10, 611	1, 800, 699	9	1, 500				4, 600	1, 806, 799
Erie				6	1, 500				8, 000	9, 500
Luzerne	1	90	2, 200			1	90	2, 200		2, 200
Perry	3	276	7, 000			3	276	7, 000		7, 000
Philadelphia	28	10, 351	1, 487, 769	203	38, 588				1, 741, 624	3, 267, 981
Schuylkill	24	3, 168	59, 100			24	3, 168	59, 100		59, 100
Union	25	2, 250	50, 600			25	2, 250	50, 600		50, 600
Washington	135	36, 524	226, 520						8, 000	234, 520
Wayne	48	3, 110	60, 050			48	3, 110	60, 050	5, 400	65, 450
York	2	150	2, 700			2	150	2, 700	3, 300	6, 000
Total	802	204, 507	4, 676, 258	318	47, 888	122	10, 711	237, 450	1, 965, 324	6, 689, 470
RHODE ISLAND.										
Bristol	16	283	115, 000	6	540				19, 800	135, 340
Newport				40	13, 370				215, 000	228, 370
Providence				10	5, 700				125, 631	131, 331
Washington	1	96	14, 000	12	8, 000					22, 000
Total	17	379	129, 000	68	27, 610				360, 431	517, 041

a Includes wooden and iron vessels and canal boats. *b* Included with new vessels. *c* Number not given. *d* Bottoms only.

NUMBER, TONNAGE, AND VALUE OF NEW VESSELS, ETC.—Continued.

States and counties.	NEW VESSELS. (a)			BOATS.		CANAL-BOATS. (b)			Value of repairing.	Total value of all products.
	Number built.	Tonnage.	Value.	Number built.	Value.	Number built.	Tonnage.	Value.		
SOUTH CAROLINA.										
Beaufort									$3,400	$3,400
Charleston	27	1,615	$92,900						47,700	140,600
Total	27	1,615	92,900						51,100	144,000
TENNESSEE.										
Shelby	1	48	5,000							5,000
TEXAS.										
Calhoun									3,000	3,000
Chambers	2	28	2,250							2,250
Denton	1	8	450							450
Galveston	6	84	7,100							7,100
Harris	4	590	36,500						19,000	55,500
Matagorda	2	32	2,480							2,480
Orange	1	21	7,000							7,000
Total	16	758	55,780						22,000	77,780
VERMONT.										
Addison	3	330	11,000			3	330	$11,000		11,000
Franklin	1	110	3,800			1	110	3,800		3,800
Rutland	1	110	3,000			1	110	3,000		3,000
Total	5	550	17,800			5	550	17,800		17,800
VIRGINIA.										
Campbell									4,000	4,000
Elizabeth City	5	44	9,600	22	$3,600				8,000	21,200
Fairfax	1	7	600						13,474	14,074
Halifax				6	1,600					1,600
Henrico	3	180	5,000			3	180	5,000	18,500	23,500
Isle of Wight	1	10	1,100							1,100
Mathews	3	19	2,400							2,400
Middlesex	2	81	13,500							13,500
Nansemond	1	14	1,800							1,800
Norfolk	3	67	16,300						42,200	58,500
Northumberland	4	63	8,600	20	4,600				13,000	26,200
York	3	29	3,150						10,000	13,150
Total	26	514	62,050	48	9,800	3	180	5,000	109,174	181,024
WASHINGTON TERRITORY.										
Clallam	1	43	3,500							3,500
Clarke	1	48	6,000							6,000
Island	1	6	800							800
Jefferson	4	745	80,000							80,000
King	4	840	57,500						21,000	78,500
Pacific	1	15	2,000							2,000
Pierce	1	38	2,800							2,800
Thurston				80	1,900					1,900
Walla Walla	1	34	9,000							9,000
Total	14	1,769	161,600	80	1,900				21,000	184,500
WEST VIRGINIA.										
Braxton			5,280							5,280
Jackson	4	1,341	73,000							73,000
Kanawha	51	9,145	31,100						3,900	35,000
Mason	14	4,603	61,300						6,000	67,300
Ohio	9	730	27,550							27,550
Pleasant	6	720	5,000							5,000
Tyler	1	188	18,000							18,000
Total	85	16,727	221,230						9,900	231,130
WISCONSIN.										
Brown	3	604	59,000						24,000	83,000
Dane				25	2,000					2,000
Door	3	134	18,000							18,000
La Crosse	3	300	28,000						17,600	45,600
Manitowoc	7	1,382	81,000						24,000	105,000
Milwaukee	3	621	61,000	32	3,400				237,305	301,705
Racine	1	14	5,000						7,500	12,500
Sheboygan	1	24	2,000							2,000
Walworth				20	6,500					6,500
Total	21	3,079	254,000	77	11,900				310,405	576,305

a Includes wooden and iron vessels and canal-boats.

b Included with new vessels.

NUMBER, TONNAGE, AND VALUE OF IRON VESSELS BUILT AND REPAIRED DURING THE CENSUS YEAR, BY COUNTIES.

States and counties.	NEW VESSELS.			Value of repairing.	Total value of all products.
	Number built.	Tonnage.	Value.		
The United States	67	31,347	$5,096,293	$1,298,545	$6,394,838
DELAWARE.					
New Castle	22	8,925	1,262,800	440,545	1,703,345
MARYLAND.					
Baltimore (city)	1	55	17,500	160,000	177,500
MASSACHUSETTS.					
Suffolk	.....	.....	.....	80,000	80,000
MICHIGAN.					
Wayne	3	1,533	387,500	.....	387,500
MISSOURI.					
Saint Louis (*a*)	7	2,740	241,000	.....	241,000
NEW JERSEY.					
Camden	4	382	75,875	29,000	104,875
NEW YORK.					
Erie	4	150	15,000	27,000	42,000
Orange	2	529	74,000	.....	74,000
Total	6	679	89,000	27,000	116,000
PENNSYLVANIA.					
Allegheny	5	550	84,000	.....	84,000
Delaware	5	10,611	1,792,600	.....	1,792,600
Philadelphia	14	5,872	1,145,919	562,000	1,707,919
Total	24	17,033	3,022,618	562,000	3,584,618

a Includes city of Saint Louis.

NUMBER AND TONNAGE OF VESSELS, NUMBER OF ESTABLISHMENTS, CAPITAL, AVERAGE VALUE OF

A—AGGREGATE.

	States and Territories.	Boats.	Vessels repaired, as reported.	New vessels.	Tonnage of new vessels.	No. of establishments.	Capital.	Average number of hands employed.	Total amount paid in wages on vessels in the ship-yard.
		Number.	*Number.*	*Number.*			*Dollars.*		*Dollars.*
	The United States	8,026	16,507	2,415	498,878	2,188	20,970,874	21,345	12,718,813
1	Alabama					1	25,000	25	22,500
2	Arkansas			3	300	3	2,500	25	3,600
3	California	200		21	7,361	62	1,806,923	534	589,564
4	Connecticut	280	840	52	11,473	94	334,300	500	256,840
5	Delaware	100		55	31,123	18	935,200	1,576	900,322
6	Florida	45		13	217	48	30,750	40	33,580
7	Georgia			2	539	2	3,000	4	2,250
8	Illinois	85		11	1,397	28	457,000	465	247,395
9	Indiana	52		64	26,524	23	194,250	312	211,736
10	Iowa			2	860	1	25,000	75	37,000
11	Kansas			1	178	1	1,000	11	1,900
12	Kentucky	25		23	2,130	11	88,450	157	92,171
13	Louisiana	80		36	1,231	38	152,100	218	113,526
14	Maine	970	1,687	88	41,396	379	811,750	1,967	838,559
15	Maryland	133	712	131	7,499	166	1,606,535	1,178	657,789
16	Massachusetts	3,765	3,269	39	5,605	276	1,705,450	1,328	804,571
17	Michigan	210		69	15,909	72	476,775	1,537	745,033
18	Minnesota					1	10,000	16	8,000
19	Mississippi			3	33	3	2,500	4	2,860
20	Missouri			17	3,451	14	247,900	293	196,005
21	Nebraska			1	52	1	300	9	1,400
22	New Hampshire	44	8			15	15,330	26	12,243
23	New Jersey	134	2,680	53	7,455	93	943,070	930	548,807
24	New York	1,221	6,469	635	76,418	457	3,944,100	4,661	2,907,120
25	North Carolina			8	487	11	15,400	38	10,256
26	Ohio	91		55	25,132	54	423,050	773	414,360
27	Oregon			19	2,162	14	63,800	85	77,150
28	Pennsylvania	318		802	204,507	125	5,707,731	3,298	2,270,629
29	Rhode Island	68	840	17	379	22	227,700	318	194,662
30	South Carolina			27	1,615	16	46,300	94	55,990
31	Tennessee			1	48	1	500	6	600
32	Texas			16	758	16	23,350	43	30,170
33	Vermont			5	550	3	20,700	12	4,400
34	Virginia	48	2	26	514	65	185,960	146	75,526
35	Washington	80		14	1,769	11	33,000	62	51,208
36	West Virginia			85	16,727	19	55,000	99	51,510
37	Wisconsin	77		21	3,079	24	208,700	474	223,573

B—NEW VESSELS.

	States and Territories.	Boats.	Vessels repaired, as reported.	New vessels.	Tonnage of new vessels.	No. of establishments.	Capital.	Average number of hands employed.	Total amount paid in wages on vessels in the ship-yard.
	The United States			2,415	498,878	640	8,777,150	10,039	5,616,071
1	Arkansas			3	300	3	2,500	25	3,600
2	California			21	7,361	13	45,050	181	109,485
3	Connecticut			52	11,473	8	34,700	211	106,400
4	Delaware			55	31,123	12	904,400	1,105	623,997
5	Florida			13	217	13	2,150	9	7,030
6	Georgia			2	539	2	3,000	4	2,250
7	Illinois			11	1,397	8	20,250	50	24,960
8	Indiana			64	26,524	16	146,450	246	172,186
9	Iowa			2	860	(a)	5,000	20	11,000
10	Kansas			1	178	1	1,000	11	1,900
11	Kentucky			23	2,130	5	15,300	28	16,721
12	Louisiana			36	1,231	27	9,900	34	21,350
13	Maine			88	41,396	51	433,200	1,390	576,502
14	Maryland			131	7,499	37	100,300	208	96,405
15	Massachusetts			39	5,605	26	83,200	217	116,560
16	Michigan			69	15,909	47	178,600	920	431,058
17	Mississippi			3	33	2	1,500	2	1,360
18	Missouri			17	3,451	10	59,900	168	103,705
19	Nebraska			1	52	1	300	9	1,400
20	New Jersey			53	7,455	30	309,000	227	115,488
21	New York			635	76,418	142	736,250	1,742	884,887
22	North Carolina			8	487	6	4,400	12	5,056
23	Ohio			55	25,132	21	214,350	420	232,013
24	Oregon			19	2,162	12	47,000	64	57,950
25	Pennsylvania			802	204,507	58	5,184,200	2,221	1,525,120
26	Rhode Island			17	379	2	40,500	63	38,000
27	South Carolina			27	1,615	9	13,700	54	32,530
28	Tennessee			1	48	1	500	6	600
29	Texas			16	758	15	18,050	24	15,970
30	Vermont			5	550	3	20,700	12	4,400
31	Virginia			26	514	20	8,500	44	20,180
32	Washington			14	1,769	8	24,000	49	37,898
33	West Virginia			85	16,727	18	48,000	87	45,850
34	Wisconsin			21	3,079	13	61,300	167	82,160

a Included in "Repairing of vessels".

NUMBER OF HANDS EMPLOYED, AMOUNT OF WAGES PAID, MATERIALS USED, AND PRODUCTS.

A—AGGREGATE.

PRINCIPAL MATERIALS.												
Hard pine.	White pine.	White oak.	Knees.	Total quantity of lumber, including other kinds.	Iron.	Yellow metal and brass.	Duck.	Manila rope.	Hemp cordage.	Total value of all materials.	Total value of all products.	
Feet.	*Feet.*	*Feet.*	*Number.*	*Feet.*	*Pounds.*	*Pounds.*	*Yards.*	*Pounds.*	*Pounds.*	*Dollars.*	*Dollars.*	
39, 827, 372	47, 506, 048	60, 701, 360	97, 192	179, 873, 966	125, 701, 922	7, 669, 826	4, 684, 464	1, 996, 163	1, 125, 131	19, 736, 358	36, 800, 327	
30, 000	....	....	....	30, 000	40, 000	20, 000	....	....	....	25, 000	60, 000	1
32, 000	24, 000	115, 000	....	171, 000	176, 000	3, 100	700	900	....	21, 700	28, 000	2
....	....	196, 000	1, 621	6, 520, 000	2, 092, 656	1, 058, 730	151, 453	73, 840	36, 880	959, 349	1, 797, 639	3
2, 777, 000	604, 080	722, 900	3, 320	4, 793, 450	1, 042, 156	60, 800	85, 870	38, 981	41, 142	430, 425	767, 660	4
1, 966, 500	1, 886, 500	2, 217, 800	4, 651	6, 411, 800	13, 045, 744	135, 866	65, 602	67, 097	74, 804	964, 275	2, 162, 503	5
95, 100	....	38, 800	....	176, 400	188, 160	800	10, 520	6, 530	200	49, 250	85, 050	6
95, 000	8, 000	14, 000	....	117, 000	90, 000	1, 200	550	750	....	13, 700	17, 000	7
....	1, 284, 500	3, 631, 800	45	5, 187, 300	1, 180, 400	7, 250	761, 350	2, 580	....	492, 010	862, 098	8
....	1, 569, 100	4, 878, 300	....	7, 046, 400	3, 173, 600	47, 900	28, 800	36, 300	....	520, 840	810, 655	9
....	160, 000	800, 000	....	460, 000	139, 000	4, 000	1, 000	1, 250	....	62, 000	112, 000	10
....	30, 000	60, 000	....	90, 000	72, 000	1, 000	400	380	....	23, 000	26, 000	11
2, 500	1, 352, 500	1, 451, 000	....	3, 291, 000	569, 699	3, 700	2, 250	2, 350	....	126, 550	240, 015	12
233, 100	....	72, 500	40	423, 600	362, 230	5, 100	85, 030	7, 120	680	162, 405	343, 525	13
13, 882, 112	3, 064, 208	5, 193, 710	26, 560	25, 866, 351	9, 081, 416	467, 956	601, 298	446, 862	373, 712	1, 935, 857	2, 909, 846	14
4, 596, 700	3, 430, 200	2, 376, 500	3, 440	10, 536, 400	3, 299, 358	514, 554	408, 940	118, 920	151, 600	884, 299	1, 788, 630	15
2, 107, 760	2, 065, 860	1, 877, 650	8, 750	6, 958, 745	2, 955, 965	1, 044, 611	423, 275	94, 235	125, 000	1, 173, 640	2, 281, 666	16
....	2, 482, 000	6, 122, 000	6, 383	8, 636, 200	9, 479, 730	48, 300	147, 776	84, 320	19, 650	1, 080, 985	2, 034, 636	17
....	....	....	....	....	....	....	....	....	....	2, 500	15, 000	18
9, 000	....	8, 000	....	19, 000	11, 600	....	610	430	150	1, 950	5, 500	19
....	978, 000	2, 165, 500	....	3, 336, 500	2, 421, 200	8, 000	4, 600	4, 150	....	313, 392	565, 187	20
....	15, 000	23, 000	....	38, 000	18, 000	400	200	300	....	7, 000	9, 000	21
10, 000	39, 600	16, 400	70	74, 000	19, 300	....	10, 900	....	....	14, 369	30, 070	22
1, 827, 800	1, 665, 300	2, 274, 300	5, 620	6, 279, 900	2, 455, 048	211, 958	87, 940	47, 687	58, 316	649, 194	1, 384, 629	23
7, 052, 800	10, 461, 000	14, 535, 900	28, 103	35, 905, 020	16, 292, 176	3, 072, 264	811, 130	267, 121	84, 477	4, 055, 637	7, 985, 044	24
232, 000	13, 000	25, 000	310	270, 000	124, 400	2, 600	1, 300	1, 560	....	32, 075	57, 219	25
40, 000	1, 037, 000	7, 793, 500	2, 518	10, 166, 500	7, 635, 020	74, 900	157, 750	100, 350	16, 300	985, 960	1, 552, 210	26
....	....	12, 500	125	836, 000	420, 700	5, 200	3, 210	8, 500	2, 080	124, 400	200, 500	27
2, 099, 300	10, 960, 800	7, 908, 900	6, 055	24, 321, 600	43, 810, 621	763, 487	639, 580	523, 520	162, 400	3, 610, 367	6, 689, 470	28
185, 000	178, 300	190, 600	1, 380	726, 900	952, 058	65, 000	4, 100	5, 400	....	266, 858	517, 041	29
584, 600	10, 400	40, 100	436	680, 100	220, 600	900	16, 080	2, 810	....	55, 250	144, 000	30
8, 000	3, 000	18, 000	....	29, 000	28, 000	300	200	300	....	4, 100	5, 000	31
278, 100	8, 800	167, 100	....	459, 500	129, 500	14, 750	8, 180	13, 840	18, 590	40, 340	77, 780	32
....	120, 400	63, 800	102	184, 200	52, 000	....	....	1, 420	....	9, 200	17, 800	33
403, 000	30, 800	190, 600	931	720, 900	183, 125	8, 500	9, 270	7, 240	4, 350	74, 578	181, 024	34
....	....	16, 000	147	800, 000	519, 700	7, 000	6, 000	6, 700	3, 800	121, 300	184, 500	35
....	2, 093, 000	1, 228, 000	....	3, 363, 000	389, 800	3, 200	3, 900	6, 400	....	162, 300	231, 130	36
....	1, 081, 100	3, 755, 600	1, 635	4, 848, 200	2, 231, 400	6, 500	184, 500	16, 020	1, 000	268, 303	576, 305	37

B—NEW VESSELS.

20, 658, 282	33, 072, 968	52, 461, 950	69, 908	131, 234, 191	99, 296, 770	1, 294, 808	670, 704	1, 374, 618	736, 931	11, 944, 212	19, 225, 714	
32, 000	24, 000	115, 000	....	171, 000	176, 000	3, 100	700	900	....	21, 700	28, 000	1
....	....	101, 000	1, 615	8, 880, 000	1, 811, 156	51, 650	20, 653	33, 540	16, 880	548, 618	770, 696	2
2, 445, 000	154, 080	446, 000	1, 965	3, 407, 600	817, 676	28, 300	17, 385	26, 331	38, 142	276, 550	413, 009	3
1, 881, 500	1, 858, 500	2, 029, 800	4, 101	6, 100, 800	11, 390, 744	136, 866	46, 602	67, 097	74, 804	758, 289	1, 614, 969	4
38, 100	....	34, 800	....	77, 900	54, 400	800	2, 020	2, 350	200	17, 450	25, 000	5
95, 000	8, 000	14, 000	....	117, 000	90, 000	1, 200	550	750	....	13, 700	17, 000	6
....	212, 500	611, 800	45	859, 800	365, 900	7, 050	1, 350	2, 580	....	100, 890	137, 300	7
....	1, 434, 100	4, 578, 300	....	6, 611, 400	2, 071, 100	47, 900	13, 800	36, 300	....	500, 290	726, 680	8
....	160, 000	280, 000	....	440, 000	115, 000	4, 000	1, 600	1, 250	....	53, 000	70, 000	9
....	30, 000	60, 000	....	90, 000	72, 000	1, 000	400	380	....	23, 000	26, 000	10
2, 500	512, 500	261, 000	....	981, 000	329, 699	3, 700	2, 250	2, 350	....	62, 150	86, 215	11
228, 100	....	72, 000	40	375, 100	360, 030	4, 300	7, 130	6, 320	680	73, 080	105, 525	12
13, 166, 072	2, 327, 038	4, 686, 600	21, 828	23, 205, 811	8, 806, 843	321, 202	228, 738	413, 962	335, 512	1, 532, 346	2, 174, 650	13
527, 200	1, 321, 200	1, 581, 500	1, 600	3, 429, 900	1, 252, 448	3, 700	25, 240	87, 660	31, 600	201, 545	320, 260	14
1, 060, 760	347, 550	767, 150	2, 857	2, 280, 460	1, 266, 086	10, 201	31, 345	38, 750	43, 000	255, 361	391, 655	15
....	1, 577, 200	5, 220, 600	4, 478	6, 806, 800	8, 321, 570	46, 500	51, 996	88, 940	19, 650	842, 115	1, 390, 050	16
9, 000	....	8, 000	....	19, 000	11, 600	....	610	430	150	1, 450	3, 500	17
....	278, 000	335, 500	....	628, 500	1, 871, 260	8, 000	4, 600	4, 150	....	231, 392	358, 487	18
....	15, 000	23, 000	....	38, 000	18, 000	400	200	300	....	7, 000	9, 000	19
1, 122, 500	480, 700	1, 240, 800	3, 409	2, 802, 400	1, 568, 794	26, 185	26, 750	42, 267	58, 316	248, 561	409, 714	20
5, 802, 000	7, 888, 600	10, 862, 800	16, 691	26, 431, 820	9, 910, 842	48, 681	45, 510	150, 931	84, 477	1, 921, 523	3, 145, 536	21
232, 000	13, 000	25, 000	310	270, 000	124, 400	2, 600	1, 300	1, 560	....	14, 875	22, 650	22
40, 000	1, 779, 000	7, 415, 500	2, 248	9, 504, 500	6, 082, 800	58, 800	35, 550	98, 730	16, 300	821, 550	1, 127, 600	23
....	....	12, 500	125	836, 000	420, 700	5, 200	3, 210	8, 500	2, 080	114, 300	176, 600	24
1, 919, 800	10, 071, 500	7, 872, 100	5, 240	22, 516, 000	36, 721, 231	380, 783	60, 285	256, 040	87, 400	2, 706, 107	4, 676, 258	25
60, 000	79, 000	63, 000	990	375, 000	448, 000	52, 000	2, 600	3, 400	....	65, 500	129, 000	26
469, 600	10, 400	16, 100	436	535, 100	163, 600	900	3, 080	2, 810	....	37, 550	92, 900	27
8, 000	3, 000	18, 000	....	29, 000	28, 000	800	200	300	....	4, 100	5, 000	28
258, 100	8, 300	157, 100	....	429, 500	113, 500	14, 750	8, 180	13, 840	18, 590	34, 940	55, 780	29
....	120, 400	63, 800	102	184, 200	52, 000	....	....	1, 420	....	9, 200	17, 800	30
165, 000	16, 300	98, 200	641	284, 000	133, 900	....	6, 870	6, 860	4, 350	31, 500	62, 050	31
....	....	16, 000	147	856, 000	509, 100	7, 000	6, 600	6, 700	3, 800	114, 100	161, 600	32
....	2, 068, 000	1, 198, 000	....	3, 303, 000	367, 300	3, 200	3, 900	6, 400	....	159, 600	221, 230	33
....	390, 100	2, 668, 000	955	3, 058, 100	1, 941, 700	6, 500	9, 500	16, 020	1, 000	140, 880	254, 000	34

NUMBER AND TONNAGE OF VESSELS, NUMBER OF ESTABLISHMENTS, CAPITAL, AVERAGE

C—REPAIRING OF VESSELS.

	States and Territories.	Boats.	New vessels.	Tonnage of new vessels.	Boats built.	No. of establishments.	Capital.	Average number of hands employed.	Total amount paid in wages on vessels in the ship-yard.
		Number.	Number.		Number.		Dollars.		Dollars.
	The United States	...	...	...	...	812	11, 882, 050	10, 671	6, 730, 136
1	Alabama	...	...	...	...	1	25, 000	25	22, 500
2	California	...	...	...	...	40	1, 754, 423	326	368, 746
3	Connecticut	...	...	...	...	22	279, 900	255	136, 520
4	Delaware	...	...	...	...	5	25, 800	465	272, 713
5	Florida	...	...	...	...	6	25, 700	25	18, 600
6	Illinois	...	...	...	...	17	435, 450	408	218, 635
7	Indiana	...	...	...	...	5	47, 000	63	37, 950
8	Iowa	...	...	...	...	1	20, 000	55	26, 000
9	Kentucky	...	...	...	...	5	78, 000	127	75, 000
10	Louisiana	...	...	...	...	9	139, 700	173	85, 176
11	Maine	...	...	...	...	100	346, 775	520	238, 380
12	Maryland	...	...	...	...	70	1, 497, 125	931	542, 529
13	Massachusetts	...	...	...	...	140	1, 586, 925	974	610, 917
14	Michigan	...	...	...	...	17	290, 700	603	307, 943
15	Minnesota	...	...	...	...	1	10, 000	16	8, 000
16	Mississippi	...	...	...	...	1	1, 000	2	1, 500
17	Missouri	...	...	...	...	4	188, 000	125	92, 800
18	New Hampshire	...	...	...	...	7	11, 930	22	10, 048
19	New Jersey	...	...	...	...	48	621, 700	679	419, 992
20	New York	...	...	...	...	192	3, 126, 550	2, 750	1, 908, 802
21	North Carolina	...	...	...	...	5	11, 000	26	14, 200
22	Ohio	...	...	...	...	28	202, 600	333	174, 142
23	Oregon	...	...	...	...	2	16, 300	21	19, 200
24	Pennsylvania	...	...	...	...	48	509, 281	1, 044	733, 795
25	Rhode Island	...	...	...	...	8	172, 000	284	144, 927
26	South Carolina	...	...	...	...	7	82, 000	40	23, 460
27	Texas	...	...	...	...	1	5, 800	19	14, 200
28	Virginia	...	...	...	...	13	175, 800	80	40, 648
29	Washington	...	...	...	...	2	8, 000	12	12, 400
30	West Virginia	...	...	...	...	1	7, 000	12	6, 160
31	Wisconsin	...	...	...	...	6	145, 500	297	135, 663

D—BOATS.

	States and Territories.	Boats.	New vessels.	Tonnage of new vessels.	Boats built.	No. of establishments.	Capital.	Average number of hands employed.	Total amount paid in wages on vessels in the ship-yard.
	The United States	...	...	...	8, 026	736	320, 665	635	367, 606
1	California	...	...	...	200	9	7, 450	27	21, 338
2	Connecticut	...	...	...	280	64	19, 700	84	13, 929
3	Delaware	...	...	...	100	1	5, 000	6	3, 612
4	Florida	...	...	...	45	29	2, 900	12	7, 950
5	Illinois	...	...	...	85	3	1, 800	7	3, 800
6	Indiana	...	...	...	52	2	800	3	1, 600
7	Kentucky	...	...	...	25	1	150	2	450
8	Louisiana	...	...	...	80	2	2, 500	11	7, 000
9	Maine	...	...	...	970	228	31, 775	57	28, 677
10	Maryland	...	...	...	133	59	9, 110	39	18, 855
11	Massachusetts	...	...	...	3, 765	110	95, 325	137	77, 094
12	Michigan	...	...	...	210	8	7, 475	14	6, 932
13	New Hampshire	...	...	...	44	8	3, 400	4	2, 195
14	New Jersey	...	...	...	134	15	12, 870	24	13, 327
15	New York	...	...	...	1, 221	123	81, 800	169	113, 850
16	Ohio	...	...	...	91	5	6, 100	11	7, 605
17	Pennsylvania	...	...	...	318	19	14, 250	33	20, 714
18	Rhode Island	...	...	...	68	12	15, 200	21	11, 735
19	Virginia	...	...	...	48	32	1, 660	13	5, 698
20	Washington	...	...	...	80	1	1, 000	1	1, 000
21	Wisconsin	...	...	...	77	5	1, 900	10	5, 750

E—OCEAN, COAST, AND RIVER VESSELS.

	States and Territories.	Boats.	New vessels.	Tonnage of new vessels.	Boats built.	No. of establishments.	Capital.	Average number of hands employed.	Total amount paid in wages on vessels in the ship-yard.
	The United States	7, 240	731	159, 325	...	1, 645	16, 806, 599	14, 284	9, 092, 538
1	Alabama	...	...	...	...	1	25, 000	25	22, 500
2	California	200	21	7, 361	...	62	1, 806, 923	534	589, 564
3	Connecticut	280	52	11, 478	...	94	334, 300	500	256, 849
4	Delaware	100	55	31, 123	...	18	935, 200	1, 576	900, 322
5	Florida	45	13	217	...	48	30, 750	46	33, 580
6	Georgia	...	2	539	...	2	3, 000	4	2, 250
7	Louisiana	80	28	864	...	31	147, 900	208	102, 626
8	Maine	970	88	41, 396	...	379	811, 750	1, 967	838, 559
9	Maryland	133	71	3, 229	...	159	1, 587, 535	1, 103	624, 539
10	Massachusetts	3, 765	39	5, 605	...	276	1, 765, 450	1, 328	804, 571
11	Mississippi	...	3	33	...	3	2, 500	4	2, 860
12	New Hampshire	44	...	...	...	15	15, 330	26	12, 243
13	New Jersey	134	43	6, 445	...	74	821, 170	787	469, 762
14	New York	1, 061	150	22, 574	...	275	2, 601, 850	2, 821	2, 041, 988
15	North Carolina	...	8	487	...	11	15, 400	38	19, 256
16	Oregon	...	19	2, 162	...	14	63, 300	85	77, 150
17	Pennsylvania	232	33	20, 962	...	55	5, 324, 231	2, 588	1, 890, 673
18	Rhode Island	68	17	379	...	22	227, 700	318	104, 662
19	South Carolina	...	27	1, 615	...	16	46, 300	94	55, 090
20	Texas	...	16	758	...	16	23, 850	43	30, 170
21	Virginia	48	23	334	...	63	184, 660	132	71, 126
22	Washington	80	14	1, 769	...	11	33, 000	62	51, 208

NUMBER OF HANDS EMPLOYED, AMOUNT OF WAGES PAID, MATERIALS USED, ETC.—Continued.

C—REPAIRING OF VESSELS.

PRINCIPAL MATERIALS.												
Hard pine.	White pine.	White oak.	Knees.	Total quantity of lumber, including other kinds.	Iron.	Yellow metal and brass.	Duck.	Manila rope.	Hemp cordage.	Total value of all materials.	Total value of all products.	
Feet.	*Feet.*	*Feet.*	*Number.*	*Feet.*	*Pounds.*	*Pounds.*	*Yards.*	*Pounds.*	*Pounds.*	*Dollars.*	*Dollars.*	
9,279,340	13,048,870	16,505,620	23,527	45,355,100	26,016,654	6,355,383	3,965,105	586,800	388,200	7,422,914	16,697,614	
30,000	....	....	....	30,000	40,000	20,000	....	....	....	25,000	60,000	1
....	....	89,000	6	2,654,000	277,700	1,007,080	130,000	40,000	20,000	393,992	969,398	2
330,000	409,000	258,500	1,135	1,233,500	200,800	32,500	56,165	2,000	3,000	136,780	317,451	3
85,000	80,000	180,000	550	205,000	1,617,000	....	19,000	....	....	195,325	520,097	4
41,000	....	4,000	....	68,000	66,000	....	13,000	....	....	18,000	44,000	5
....	1,010,000	3,000,000	....	4,240,000	763,000	....	760,000	....	....	388,840	745,743	6
....	135,000	800,000	....	435,000	202,500	....	15,000	....	....	28,050	80,875	7
....	....	20,000	....	20,000	24,000	....	....	....	....	9,000	42,000	8
....	840,000	1,190,000	....	2,310,000	240,000	....	....	....	....	64,300	161,800	9
....	....	....	....	....	....	....	76,000	....	....	84,325	222,400	10
716,040	519,870	423,520	4,497	2,220,100	1,130,443	146,354	371,740	32,200	38,200	376,917	681,378	11
3,834,000	2,097,000	787,000	1,750	6,882,000	2,041,150	510,374	380,000	80,000	120,000	666,296	1,423,870	12
1,130,000	1,048,700	871,800	3,405	3,539,300	1,620,450	1,024,620	380,300	46,100	82,000	836,478	1,703,284	13
....	866,000	870,000	1,610	1,761,000	1,150,000	1,800	95,000	....	....	243,347	631,460	14
....	....	....	....	....	....	....	....	....	....	2,500	15,000	15
....	....	....	....	....	....	....	....	....	....	500	2,000	16
....	700,000	1,830,000	....	2,708,000	550,000	....	....	....	....	82,000	206,700	17
10,000	23,000	8,000	50	49,000	6,500	....	10,900	....	....	12,284	25,630	18
705,300	1,210,100	1,010,900	2,109	3,331,300	879,204	185,473	60,000	5,000	....	384,058	940,455	19
1,758,000	2,431,700	3,464,900	6,060	8,822,900	6,255,820	3,007,718	762,000	114,500	....	2,021,064	4,575,551	20
....	....	....	....	....	....	....	....	....	....	17,200	34,569	21
....	108,000	361,000	270	497,000	933,000	16,000	120,000	....	....	155,760	406,210	22
....	....	....	....	....	....	....	....	....	....	10,100	29,900	23
178,000	820,000	505,000	775	1,683,000	7,081,500	381,964	578,000	267,000	125,000	883,895	1,965,324	24
125,000	77,000	112,000	250	314,000	408,078	13,000	....	....	....	189,183	360,431	25
115,000	....	24,000	....	145,000	57,000	....	13,000	....	....	17,700	51,100	26
20,000	....	10,000	....	30,000	16,000	....	....	....	....	5,400	22,000	27
202,000	14,000	91,000	290	307,000	47,500	8,500	....	....	....	40,538	109,174	28
....	....	....	....	18,000	9,000	....	....	....	....	6,800	21,000	29
....	30,000	30,000	....	60,000	22,000	....	....	....	....	2,700	9,000	30
....	679,000	1,065,000	680	1,752,000	288,000	....	125,000	....	....	123,673	310,405	31
D—BOATS.												
394,800	1,884,710	733,790	3,762	3,284,675	388,469	19,635	48,655	34,745	....	360,232	876,999	
....	....	6,000	....	46,000	3,800	....	800	300	....	16,730	57,545	1
2,000	41,000	18,400	220	92,350	23,080	....	12,320	10,650	....	17,086	37,200	2
....	3,000	8,000	....	16,000	38,000	....	....	....	....	10,661	18,437	3
16,000	....	....	....	30,500	17,760	....	4,500	4,180	....	7,800	10,050	4
....	12,000	20,000	....	38,000	1,500	200	....	....	....	2,280	9,050	5
....	....	....	....	....	....	....	....	....	....	1,500	3,100	6
....	....	....	....	....	....	....	....	....	....	100	1,000	7
10,000	....	500	....	48,500	2,200	800	1,900	800	....	5,000	15,000	8
....	217,800	83,590	240	350,440	44,630	400	820	700	....	26,594	53,818	9
235,500	12,000	8,000	....	274,500	5,760	480	3,700	1,260	....	16,458	45,000	10
1,000	669,610	238,700	2,488	1,138,985	68,529	700	11,630	9,385	....	81,801	186,727	11
....	89,400	23,000	300	68,400	8,160	....	780	380	....	4,523	13,117	12
....	16,600	8,400	20	25,000	12,800	....	....	....	....	2,085	4,440	13
....	24,500	22,600	12	86,200	7,050	300	1,190	420	....	16,575	34,460	14
2,800	195,700	208,200	352	650,300	116,505	15,865	3,620	1,690	....	112,150	263,957	15
....	50,000	17,000	....	75,000	19,220	100	2,200	1,620	....	8,650	18,400	16
1,500	69,300	31,800	40	122,600	7,890	790	1,295	480	....	20,365	47,868	17
....	22,300	15,600	90	37,000	5,080	....	1,500	2,000	....	12,175	27,610	18
126,000	....	1,400	....	129,900	1,725	....	2,400	880	....	2,540	9,800	19
....	....	....	....	16,000	1,600	....	....	....	....	400	1,900	20
....	12,000	22,600	....	38,100	1,700	....	....	....	....	3,750	11,900	21
E—OCEAN, COAST, AND RIVER VESSELS.												
38,501,272	16,434,948	19,999,260	75,093	91,580,066	85,876,577	7,403,526	3,184,138	1,402,242	1,083,434	13,011,784	25,149,750	
30,000	....	....	....	30,000	40,000	20,000	....	....	....	25,000	60,000	1
....	....	196,000	1,621	6,580,000	2,092,656	1,058,730	151,453	73,840	36,880	959,349	1,797,639	2
2,777,000	604,080	722,900	3,320	4,793,450	1,042,156	60,800	85,670	38,081	41,142	430,425	767,060	3
1,906,500	1,886,500	2,217,800	4,651	6,411,800	13,045,744	135,866	65,602	67,097	74,804	964,275	2,162,503	4
95,100	....	38,800	....	176,400	138,160	800	19,520	6,530	200	43,250	85,050	5
95,000	8,000	14,000	....	117,000	90,000	1,200	550	750	....	13,700	17,000	6
134,100	....	39,500	40	240,600	102,230	1,400	83,030	4,870	680	115,905	279,525	7
13,882,112	3,064,208	5,193,710	26,560	25,806,351	9,981,416	467,956	601,298	446,862	373,712	1,935,857	2,900,846	8
4,593,700	2,175,200	1,454,500	3,422	8,356,400	2,644,358	514,854	408,940	106,340	151,600	814,799	1,674,130	9
2,197,760	2,065,860	1,877,650	8,750	6,958,745	2,955,965	1,044,611	423,275	94,235	125,000	1,173,640	2,281,666	10
9,000	....	8,000	....	19,000	11,600	....	610	430	150	1,950	5,500	11
10,000	39,600	16,400	70	74,000	19,300	....	10,900	....	....	14,369	30,070	12
1,776,800	1,421,600	1,938,400	5,165	5,649,300	2,310,483	203,958	87,940	46,737	58,316	583,264	1,214,829	13
7,145,200	2,748,500	4,547,300	14,765	16,022,420	9,334,277	3,064,014	595,170	160,290	29,730	2,700,146	5,441,588	14
232,000	13,000	25,000	310	270,000	124,400	2,600	1,300	1,500	....	32,075	57,219	15
....	....	12,500	125	836,000	420,700	5,200	3,210	8,500	2,080	124,400	206,500	16
2,091,300	2,180,500	1,092,400	3,450	5,776,200	39,533,149	725,887	600,640	303,830	162,400	2,524,654	5,063,080	17
185,000	178,300	190,600	1,330	726,000	952,058	65,000	4,100	5,400	....	266,858	517,041	18
584,600	10,400	40,100	436	680,100	220,600	900	16,080	2,810	....	55,250	144,000	19
278,100	8,800	167,100	....	459,500	129,500	14,750	8,180	13,840	18,590	40,340	77,780	20
418,000	30,300	190,600	931	645,900	159,125	8,500	9,270	6,640	4,350	70,978	172,024	21
....	....	16,000	147	800,000	519,700	7,000	6,600	6,700	3,800	121,300	184,500	22

NUMBER AND TONNAGE OF VESSELS, NUMBER OF ESTABLISHMENTS, CAPITAL, AVERAGE

F—NORTHERN LAKES.

	States.	Boats.	New vessels.	Tonnage of new vessels.	No. of establishments.	Capital.	Average number of hands employed.	Total amount paid in wages on vessels in the ship-yard.
		Number.	*Number.*			*Dollars.*		*Dollars.*
	The United States	629	142	30,752	199	1,865,325	3,352	1,664,017
1	Illinois	85	2	50	19	352,300	339	176,975
2	Michigan	210	69	15,909	72	476,775	1,537	745,933
3	New York	160	35	3,957	59	592,500	629	321,081
4	Ohio	91	18	8,057	26	246,050	430	231,905
5	Pennsylvania	6	....	....	1	10,000	8	4,200
6	Wisconsin	77	18	2,779	22	187,700	400	184,823

G—WESTERN RIVERS.

	States.	Boats.	New vessels.	Tonnage of new vessels.	No. of establishments.	Capital.	Average number of hands employed.	Total amount paid in wages on vessels in the ship-yard.
	The United States	157	899	242,004	155	1,227,500	1,996	1,183,072
1	Arkansas	....	3	300	3	2,500	25	3,600
2	Illinois	....	8	1,259	7	102,000	118	65,720
3	Indiana	52	64	26,524	23	194,250	312	211,736
4	Iowa	....	2	860	1	25,000	75	37,000
5	Kansas	....	1	178	1	1,000	11	1,900
6	Kentucky	25	23	2,130	11	88,450	157	92,171
7	Louisiana	....	8	367	7	4,200	15	10,900
8	Minnesota	....	....	....	1	10,000	16	8,000
9	Missouri	....	17	3,451	14	247,900	293	196,005
10	Nebraska	....	1	52	1	300	9	1,400
11	Ohio	....	36	17,064	14	155,000	266	153,420
12	Pennsylvania	80	647	172,834	50	320,400	520	310,300
13	Tennessee	....	1	48	1	500	6	600
14	West Virginia	....	85	16,727	19	55,000	99	51,510
15	Wisconsin	....	3	300	2	21,000	74	38,750

H—CANAL-BOATS.

	States.	Boats.	New vessels.	Tonnage of new vessels.	No. of establishments.	Capital.	Average number of hands employed.	Total amount paid in wages on vessels in the ship-yard.
	The United States	....	643	66,707	189	1,080,450	1,713	773,286
1	Illinois	....	1	88	2	2,700	8	4,700
2	Maryland	....	60	4,270	7	19,000	75	33,250
3	New Jersey	....	10	1,010	19	121,900	143	79,045
4	New York	....	441	49,887	123	749,750	1,211	544,000
5	Ohio	....	1	11	14	22,000	68	29,035
6	Pennsylvania	....	122	10,711	19	143,100	182	74,396
7	Vermont	....	5	550	3	20,700	12	4,400
8	Virginia	....	3	180	2	1,300	14	4,400

I—IRON VESSELS. (*a*)

	States.	Boats.	New vessels.	Tonnage of new vessels.	No. of establishments.	Capital.	Average number of hands employed.	Total amount paid in wages on vessels in the ship-yard.
	The United States	....	67	31,347	16	7,497,000	4,262	2,732,590
1	Delaware	....	22	8,925	2	800,000	1,252	753,953
2	Maryland	....	1	55	2	1,000,000	223	134,000
3	Massachusetts	....	....	....	2	500,000	60	35,500
4	Michigan	....	3	1,533	1	100,000	240	155,600
5	Missouri	....	7	2,740	1	30,000	120	78,412
6	New Jersey	....	4	382	1	200,000	72	43,600
7	New York	....	6	679	2	62,000	77	46,000
8	Pennsylvania	....	24	17,033	5	4,805,000	2,218	1,485,534

a Also included with preceding classes.

NUMBER OF HANDS EMPLOYED, AMOUNT OF WAGES PAID, MATERIALS USED, ETC.—Continued.

F—NORTHERN LAKES.

PRINCIPAL MATERIALS.												
Hard pine.	White pine.	White oak.	Knees.	Total quantity of lumber, including other kinds.	Iron.	Yellow metal and brass.	Duck.	Manila rope.	Hemp cordage.	Total value of all materials.	Total value of all products.	
Feet.	*Feet.*	*Feet.*	*Number.*	*Feet.*	*Pounds.*	*Pounds.*	*Yards.*	*Pounds.*	*Pounds.*	*Dollars.*	*Dollars.*	
3,000	5,951,300	18,967,700	13,783	25,172,600	19,175,755	86,000	1,398,176	155,956	41,697	2,642,455	4,870,645	
....	458,500	1,777,300	27	2,241,800	506,500	650	760,000	150	....	356,220	650,833	1
....	2,482,600	6,122,600	6,383	8,636,200	9,479,730	48,800	147,776	84,320	19,650	1,089,985	2,034,636	2
3,000	1,421,600	3,145,500	3,186	4,764,200	2,906,825	8,250	215,960	16,746	4,747	455,307	848,321	3
....	585,000	4,365,500	2,502	4,958,500	4,211,020	23,800	140,600	39,470	16,300	476,400	796,650	4
....	2,500	1,200	....	3,700	280	....	540	150	....	3,600	9,500	5
....	1,001,100	3,555,600	1,635	4,568,200	2,071,400	5,000	133,300	15,120	1,000	260,943	530,705	6

G—WESTERN RIVERS.

181,500	16,008,600	20,019,000	....	41,684,100	15,141,519	170,950	102,150	322,310	....	2,856,745	4,450,587	
32,000	24,000	115,000	....	171,000	176,000	3,100	700	900	....	21,700	28,000	1
....	766,000	1,830,500	....	2,861,500	622,400	6,400	1,350	2,430	....	133,190	232,060	2
....	1,569,100	4,878,300	....	7,046,400	3,173,600	47,900	28,800	36,300	....	529,840	810,655	3
....	160,000	300,000	....	460,000	139,000	4,000	1,600	1,250	....	62,000	112,000	4
....	30,000	60,000	....	90,000	72,000	1,000	400	380	....	23,000	26,000	5
2,500	1,352,500	1,451,000	....	3,291,000	569,699	3,700	2,250	2,350	....	126,550	249,015	6
99,000	....	33,000	....	183,000	260,000	3,700	1,400	2,250	....	46,500	64,000	7
....	....	....	....	....	....	....	....	....	....	2,500	15,000	8
....	978,000	2,165,500	....	3,336,500	2,421,260	8,000	4,000	4,150	....	313,392	565,187	9
....	15,000	23,000	....	38,000	18,000	400	200	300	....	7,000	9,000	10
40,000	1,346,000	3,408,000	....	5,182,000	3,419,600	51,100	17,150	60,700	....	494,200	701,700	11
....	7,592,000	4,908,700	....	15,352,700	3,692,660	36,650	38,400	203,700	....	928,113	1,355,340	12
8,000	3,000	18,000	....	29,000	28,000	300	200	300	....	4,100	5,000	13
....	2,093,000	1,228,000	....	3,363,000	389,300	3,200	3,900	6,400	....	162,300	231,130	14
....	80,000	200,000	....	280,000	160,000	1,500	1,200	900	....	7,360	45,600	15

H—CANAL-BOATS.

641,600	9,111,800	10,115,400	8,306	21,437,200	5,508,071	9,350	....	115,655	....	1,225,374	2,329,345	
....	10,000	24,000	18	34,000	1,500	200	....	....	....	2,600	8,300	1
3,000	1,255,000	922,000	18	2,180,000	655,000	200	....	12,580	....	69,500	114,500	2
51,000	243,700	335,900	455	630,600	135,565	8,000	....	950	....	65,930	169,800	3
504,600	6,290,000	6,843,100	5,152	15,118,400	4,051,074	....	....	84,085	....	900,184	1,695,135	4
....	6,000	20,000	16	26,000	4,400	....	....	180	....	15,360	53,860	5
8,000	1,185,800	1,006,600	2,605	3,180,000	584,532	950	....	15,840	....	159,000	260,950	6
....	120,400	63,800	102	184,200	52,000	....	....	1,420	....	9,200	17,800	7
75,000	....	....	....	75,000	24,000	....	....	600	....	3,600	9,000	8

I—IRON VESSELS. (a)

2,254,000	3,353,000	639,100	....	6,663,100	54,326,737	501,332	47,000	51,450	31,400	2,851,073	6,394,838	
723,000	1,264,000	207,000	....	2,425,000	11,981,186	118,945	17,800	15,700	8,000	692,435	1,703,345	1
....	5,000	1,000	....	6,000	468,000	400	....	250	....	28,000	177,500	2
....	....	....	....	....	196,000	....	....	....	....	35,000	80,000	3
....	285,000	40,000	....	325,000	4,502,000	16,000	2,400	1,500	....	187,000	387,500	4
....	122,000	41,500	....	163,500	1,585,000	4,000	2,500	1,500	....	153,000	241,000	5
3,000	34,000	2,000	....	39,000	1,220,000	15,600	800	1,800	....	39,200	104,875	6
....	56,000	17,000	....	76,000	875,000	5,000	1,100	900	....	55,000	116,000	7
1,528,000	1,587,000	330,600	....	3,628,600	33,499,551	341,387	22,400	29,800	23,400	1,661,438	3,584,618	8

a Also included with preceding classes.